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SOME FACTORS AFFECTING THE INTERACTION BETWEEN SUNFLOWER PLANTS AND RUST FUNGUS (*PUCCINIA HELIANTHI*)

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Interaction between sunflower plants and rust fungus, ***P. helianthi*** was strongly affected by inoculation methods, inoculum density, leaf age and wetness, sunflower cultivars, photoperiod especially after host inoculation as well as survival of urediospores.

A negative correlation between photoperiod and rust infection was reported especially when plants were illuminated after inoculation. The most inhibition effect was noticed at 24h/day of exposure to light.

Germinability and infectivity of ***P. helianthi*** urediospores were strongly affected by temperature, humidity, adhesion to host tissue and storage period. Reduction in germinability and infectivity increased with increasing temperature and storage period particularly under wet conditions. Detached urediniospores lost their viability faster than attached ones under all circumstances.

Introduction

Sunflower rust disease was first recorded by Melchers (1931) in Egypt. When infections are severe, leaves sensece prematurely, and yields may be reduced to as little as 15% of attainable yield (Lal ***et al***, 1980 and Shtienberg, 1995).

However, rust reduces not only yield, but also oil percentage, seed size, weight and kernel-to-hull ratio (McMullen, 1985). Siddiqui (1975) tested susceptibility of 15 sunflower cvs. to the disease in the field and glasshouse and found that cv. 82819 had the best available resistance. However, Sivaprakasam ***et al***. (1975) noted that none of 65 varieties tested on the field was resistant to ***P. helianthi*** but 8 varieties were less susceptible than the others.

In 1980, Abo El-Dahab ***et al***., reported that varietal resistance to natural infection with sunflower rust indicated that Egyptian variety Giza 1 was the most susceptible, while the American varieties possessed considerable level of resistance. However, rust severity varies with the environment, inoculum density, host age and

cultivar resistance (Sippell and Hall, 1982; Schuh *et al*, 1987; Velozhaban *et al*, 1991 and Shtienberg and Vintal, 1995). Adult plant resistant reaction was observed with ***P. sorghi***/sweet corn system (Headrick and Pataky, 1987). Recently, Shtienberg and Vintal (1995) found that sunflower rust severity varies with the environment, host age and cultivar resistance.

Moisture was required for rust infection and 6 to 10h of leaf wetness was sufficient to induce infection for several rust pathogens including ***P. helianthi*** (Shtienberg and Vintal, 1995).

Moreover, susceptibility of plants to phytopathogenic fungi was increased by short days, e.g. ***P. sorghi***/corn (Ouf *et al*, 1987) and ***P. recondita***/wheat (Eversmeyer *et al*., 1988).

Rapid loss of viability of urediospores during storage frequently hampers studies of host-parasite relationships by drastically reducing the number of infection in greenhouse or field tests (Davison and Voughan, 1963). Viability of urediospores of various rust species ranges from 10 days to over 2 years (Sehein, 1962).

The present study was carried out to investigate the effect of some environmental factors and urediospore longevity on sunflower/ ***P. helianthi*** interaction.

Materials and Methods

1.1. Inoculation method:

Three inoculation methods; dusting, painting and spraying were tested. Dusting method was conducted as reported by Melching (1967) and painting as described by Walters and Murray (1992) while spraying method was performed as mentioned by Shtienberg and Vintal (1995). Only lower leaf surfaces of 15-18 days old were inoculated.

Unless otherwise stated, ***P. helianthi*** urediospores were freshly harvested from sunflower cv. Giza 1 artificially inoculated with Minia isolate. Inoculated or uninoculated (healthy) plants were covered with black plastic bags for 24h to ensure complete darkness and high humidity.

1.2. Inoculum density and leaf surfaces:

Four plants of sunflower Giza-1 cv. were grown in each of 5 clay pots No. 20 under greenhouse conditions in an experiment of complete randomized plot design with three replicates. When plants were 15-18 days old, they were inoculated with urediospores suspended in 1% starch solution at concentrations of 0.0, 4.5, 2.25 and 1.12 x 10^4 spores/ml.

1.3. Leaf age:

A staggered planting schedule was used to create plants of different age as described by Shaik *et al.* (1989). Four seeds were sown in each of five 20-cm diameter pot filled with clay soil. Experiment of complete randomized block design with three replicates (blocks) was carried out.

Plants were inoculated at the same time, when they were 11, 13, 15, 17, 19 and 21 days old (sowing day is considered as day in calculating plant age). Inoculum was prepared as described before and the lower surfaces of the 1st pair leaves (Giza-1 cv.), were inoculated with painting method as described above.

1.4. Leaf wetness:

Sunflower plants, Giza-1 cv. of 15-18 days old were inoculated, irrigated and kept under polyethylene bags for 6, 8, 12, 16 and 24h to maintain high humidity . After that, polyethylene bags were removed and leaves were dried by exposing them to gentle air ventilation for approx. 10 min.

1.5. Sunflower cultivars:

An experiment of complete randomized plot design with three replicates was carried out under greenhouse conditions.

Four sunflower cvs. i,.e. Giza-1, Giza-151, Giza-161, Miak and Two hybrids e.g. Pioneer and Hybrid No.1 were grown in clay pots No. 20. When plants were 15-18 days old, lower surfaces of first leaf pairs of 40 plants were inoculated by urediospore suspension in 1% starch. Amount of 4.5 x 10^4 spores/ml were suspended in 1% starch solution. Treated plants were covered with plastic bags for 24h. After 7 days from inoculation, plants were daily examined until the 14th day to evaluate rust severity

1.6. Effect of photoperiod:

Four experimental sets were performed during February-March, 1995 and 1996 to explore the role of photoperiods on sunflower infection. Four seeds of sunflower Giza-1 cv. were sown in clay pot No.15 in 3 replicates under greenhouse conditions. When plants were 15-18 days old, the lower leaf surfaces were painted as above mentioned. Plants were incubated in dual program illuminated incubators (Percision Scientific Inc., Model 818).

A source of light was from one side, plants were lined and a distance of 15-20cm between them and light source was kept. Plant sets were exposed to cool white flourescent light of about 1200 Lux at 20±2°C for a period of 8, 14, 18 or 24h. Illumination periods started at different times as follows:

a). From sowing date to time of rust inoculation,

b). From inoculation time to rust disease assessment,

c). From sowing date to time of rust disease assessment.

The fourth set of plants was kept under 11.5h of natural day light all time of experiment to serve as control. Four pots were used per treatment and each experiment repeated 3 times. At 15-18 day-old, plants were inoculated by painting the lower surfaces of the 1st leaf pairs as mentioned before.

Disease assessment:

Leaves were daily examined for pustules development. Latent period that necessary for 50% pustules development was recorded. Disease severity was assayed according to the number of pustules per leaf unit area as described by Peterson *et al*. (1948).

2. Effect of storage conditions on longevity and infectivity of uredia

Urediospores of *P. heianthi* were collected from freshly sporulating pustules of artificially inoculated sunflower Giza-1 cv. Plants were grown under controlled greenhouse conditions during November 1994 and 1995 as described by Shihata *et al*., (1989). Leaf-free masses of urediospores were kept in muslin bags and placed in tightly closed containers with 100% relative humidity (r.h), or with calcium chloride to insure a dry conditions. The containers were stored for 120 days at temperatures of -15 5 20 and 30

In another experiment, infected leaves bearing sporulating pustules were collected, air dried and kept in paper bags, for 120 days under the same storage conditions. Detached and attached urediospores were tested for germinability and infectivity at 5, 10, 20, 40, 60, 80 and 120 days intervals as reported by Ouf *et al* . (1987). Infectivity of stored urediospores were tested by painting 15-day old sunflower plants Giza-1 cv. growning in greenhouse as described before.

Results And Discussion

It has been reported that there is evidence both for and against Vander Plank's hypothesis of stabilizing selection, depending on the conditions and the materials studied (Prud'Homme and Sackston, 1990). Also, it has been shown that the relative survival ability of a strain or race of a pathogen is the result of a complex of factors, including spore germination, penetration, pustule growth (Latent period), pustule density (number of pustules) and spore production (sporulation). All of these factors may be influenced by interactions among host, pathogen and

environment (Falahati-Rastegar *et al*, 1983). In the last few years, comparable studies have been done with sunflower rust (Prud'Homme and Sackston, 1990). However, to understand the epidemiology of *P. helianthi*, it is essential to know how it is affected by various factors of the environment (Shtienberg and Vental, 1995).

1.1. Inoculation method:

Of the three inoculation methods (Table 1) painting was the most effective technique. Disease severity resulting from leaf painting was 3 to 6-fold of that caused by spraying or dusting methods, respectively. Latent period was 9 days with painting and spraying techniques and prolonged to 10 days when dusting method was used. Number of pustules/cm^2 leaf area was the highest on painted leaves (18.8), moderate on sprayed (9.4) and lowest on dusted (7.4) ones.

1.2. Inoculum density:

A positive correlation between inoculum density of sunflower rust fungus and pustule numbers per unit of leaf area and rust severity was noticed (Table 2). These two parameters were increased by increasing inoculum density. These results are in agreement with the previous findings on cereal rusts (Falahati-Rastegar *et al*, 1981) and on other plant pathogen interactions (Sippell and Hall, 1982; Schuh *et al*, 1987). However, lower surfaces of leaves showed susceptibility to rust infection more than the upper one by at least 2 fold. It may be due to the number of stomata, humidity and lighting.

1.3. Leaf age:

On the other hand, number of pustules and disease severity were negatively correlated with leaf age (Table 3). Leaves of 21-day-old showed lowest number of pustules and disease severity, while 15 and 17-day-old leaves provided highest number of pustules and disease severity. Positive correlation between leaf age and disease latent period was expressed. Several reports on corn/rust system (Headrick and Pataky, 1987) and bean/rust system (Groth and Urs, 1982 and Shaik and Steadman, 1989) support this study.

1.4. Leaf wetness:

Data indicate that leaf wetness (Table 4) is an important factor for sunflower rust infection. Longer duration of leaf wetness proved sufficient disease severity. These findings are in line with several reports on various rust pathogens, e.g. *P. helianthi* (Shtienberg and Vintal, 1995), *P. recondita* (Eversmeyer *et al*, 1988 and de Vallavieille *et al*, 1995) and *P. orghi* (Headrick and Pataky, 1987).

Table (1): Effect of different methods of artificial inoculation on sunflower rust infection under controlled greenhouse conditions.

Inoculation method	Incubation period (day)	No. pustules/cm^2 leaf area	Disease severity %
Painting	9	18.8	65
Spraying	9	9.4	20
Dusting	10	7.4	10
L.S.D at 0.05		3.36	

Table (2): Response of sunflower Giza-1 cv. to rust infection with Minia isolate, as affected by inoculum density and infection site

Leaf surface	Inoculum density X10^4 spores/ml	Incubation period	No of. pustules/cm^2 leaf area	Disease severity %
Lower surface	1.12	10	4.4	20
	2.25	10	6.6	30
	4.5	9	17.9	65
	9.0	8	Uncountable	>90
Mean		9.25		50.5
Upper surface	1.12	10	1.4	10
	2.25	10	3.7	20
	4.5	10	6.2	30
	9.0	9	12.2	50
Mean		9.7	5.85	27.5

L.S.D at 0.05 0.56

inoculum 0.79

interaction (LxI) = 7.1

Table (3): Effect of leaf age on sunflower rust infection.

Leaf age (day)	Incubation period	No. pustules/cm^2 leaf area	Disease severity %
11	9	11.9	55
13	9	11.9	55
15	9	19.2	65
17	9	20.4	65
19	10	7.2	35
21	10	5.9	15
L.S.D at 0.05		1.76	

Table (4): Effect of leaf wetness on sunflower rust infection.

Leaf wetness duration (h)	Incubation	No. pustules/cm^2 leaf area	Rust severity %
6	-	-	-
8	9	7.2	40
12	9	8.7	45
16	9	14.2	65
24	9	15.1	65
L.S.D at 0.05		1.21	

1.5. Reaction of some sunflower cultivars:

Differences in susceptibility of sunflower cvs to *P. helianthi* infection have been reported by (Abo El-Dahab *et al*, 1980 and Gulya *et al*, 1989). Similar findings were obtained during the present investigation. Data indicate that sunflower Giza-1 cv was the most susceptible to rust infection followed by other Egyptian cultivars Giza-161 and Giza-151, while Miak cv. and sunflower hybrids were the least (Table 5).

1.6. Effect of photoperiod:

Photoperiods have substantial effect on sunflower rust infection (Table 6). A negative correlation between photoperiod and rust infection was obtained particularly when plants were illuminated after inoculation. When the photoperiod was more than 14h/day, the number of pustules/cm^2 leaf area and disease severity highly were

Table (5): Reaction of some sunflower cultivars to Minia isolate of rust fungus under controlled greenhouse conditions.

Sunflower cv.	Incubation	No. pustules/cm^2 leaf area	Disease severity %
Giza-1	9	18.3	65
Giza-151	9	15.3	60
Giza-161	9	16.4	60
Miak	9	13.2	55
Pioneer	9	12.7	55
Hybrid-1	9	12.8	55
L.S.D at 0.05		1.15	

Table (6): Reaction of sunflower Giza-1 cv. to rust infection as affected by the photoperiods. Plants were illuminated;

Photoperiod hour/day	Incubation period, day			Number of pustules/ 1cm^2 leaf area			Disease severity %		
	Illuminated treatments								
	a	b	c	a	b	c	a	b	c
8	9	9	9	13.8	11.4	11.2	50-60	50	50
14	9	9	10	13.6	9.9	7.2	50-60	40-50	30
18	9	11	11	13.6	7.5	5.3	50-60	30	20
24	9	11	11	13.3	5.9	3.2	50-60	20	10-20
Control (natural day light). Day length was about 11.5h	9	9	9	15.5	15.5	15.5	60-70	60-70	60-70
L.S.D at 0.05				0.92	1.23	1.46			

a. from sowing date to inoculation time,
b. from inoculation time to disease assessment and
c. from sowing date to disease assessment

Table (7): Effect of temperature, humidity and storage period on germinability (Germ.) and infectivity (Dis. Sev.) of detached *P. helianthi* urediospores

Storage period, day	Germination percentage and infectivity of urediospores under different stored conditions															
	-15°C				5°C				20°C				30°C			
	Wet		Dry		Wet		Dry		Wet		Dry		Wet		Dry	
	Germ %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev %
5	54.7±3.2*	55	83.3±1.8	70	50.3±7.9	50	80.6±4.6	70	32.2±1.7	35	61.8±4.3	65	8.0±0.5	10	34.8±6.8	35
10	45.0±2.1	40	80.9±4.7	70	26.0±5.6	25	60.0±4.8	65	19.5±4.2	20	55.0±9.1	60	4.0±1.7	3	14.5±1.2	15
20	25.7±1.1	15	79.4±4.5	70	15.5±2.5	15	55.0±2.9	55	6.2±0.8	4	31.8±1.9	35	1.6±0.3	0.0	7.8±0.4	10
40	13.5±1.5	10	77.0±2.5	65	6.6±0.3	5	34.0±1.1	35	0.0	0.0	16.5±1.2	15	0.0	0.0	3.7±1.5	0.0
60	2.7±0.5	1	26.8±1.1	30	2.1±0.2	1	13.4±0.7	15	-	-	0.0	0.0	0.0	0.0	0.0	-
80	1.9±1.1	0.0	12.0±0.2	10	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-
120	0.0	-	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-

* Data are means of one experiment in 4 replicates ± standard deviations (SD)

Table (8): Effect of temperature, humidity and storage period on germinability (Germ.) and disease severity of attached *P. helianthi* urediospores

Storage period, day	Germination percentage and infectivity of urediospores under different stored conditions															
	-15°C				5°C				20°C				30°C			
	Wet		Dry		Wet		Dry		Wet		Dry		Wet		Dry	
	Germ %	Dis. Sev %	Germ. %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev %
5	78.4±7.0*	65	91.8±2.2	70	60.6±3.3	60	90.7±1.6	70	38.3±1.8	45	68.2±1.9	65	8.4±0.5	10	17.2±1.3	20
10	65.6±5.0	55	90.3±3.9	70	56.2±3.1	60	82.2±1.9	65	31.8±2.7	40	66.7±2.2	60	5.6±0.6	5	16.1±0.7	7
20	58.3±7.9	50	88.3±4.7	70	48.4±9.4	50	72.4±4.1	65	15.5±1.1	15	62.0±7.1	55	3.4±1.1	0.0	15.2±1.5	15
40	31.1±6.8	20	80.8±6.9	65	18.5±9.3	15	62.0±8.2	60	5.0±2.8	2	54.8±4.8	50	3.0±1.7	0.0	11.6±2.3	5
60	21.7±1.8	20	69.4±4.4	60	16.0±4.9	15	30.0±10.4	25	0.0	-	20.8±5.2	10	0.0	-	7.5±2.6	5
80	18.7±2.4	10	59.8±1.6	50	0.0	-	15.6±4.5	15	0.0	-	10.5±3.4	5	0.0	-	5.9±1.8	1
120	9.0±1.5	5	15.0±3.5	15	0.0	-	11.8±1.9	5	0.0	-	0.0	-	0.0	-	0.0	-

* Data are means of one experiment in 4 replicates ± standard deviations (SD)

decreased and disease latent period was prolonged as well. The most disease-suppression was experienceed when the illumination period was 24h/day. This investigation concludes that photoperiod has direct effect on sunflower/rust fungus interaction. Such findings are in agreement with reports on other plant/rust fungus interaction (Ouf *et al* , 1987 and Eversmeyer *et al* , 1988).

2. Effect of storage conditions on longevity and infectivity of uredia:

Germinability and infectivity of *P. helianthi* urediniospores are strongly affected by temperature, humidity, adhesion to host tissue and storage period (Table 7 and 8). Germinability as well as infectivity gradually decreased with increasing temperature and storage period particularly under wet storage conditions. Detached urediospores lost their viability faster than attached ones under all circumstances. However, at 30°C, viability was lasted at 20 and 40 days under wet and dry storage conditions, respectively. Under -15°C viability was prolonged to 60 and 120 days in case of detached and attached spores, respectively, even under dry or wet conditions. But the percentage of survival urediniospores was different. Data also indicate that there was direct correlation between urediospores germinability and aggressiveness. Similar findings on other plant/rust fungi interactions have been reported elsewhere (Shihata *et al* , 1989 and Eversmeyer and Kramer, 1995).

References

Abo El-Dahab, M.K.; Tarabeih, A.M. and Mohamed, S.E. (1980): Studies on sunflower diseases in Egypt. Studies on sunflower rust and its control. ***Egypt. J. Phytopathology***, 12: 123-130

Davison, A.D. and Voughan, E.K. (1963): Longevity of urediospores of race 33 of ***Uromyces phaseoli*** var. ***phaseoli*** in storage. ***Phytopathology***, 53: 736-737.

de Vallavieille, P.C.; Huber, L.; Leconte, M. and Goyeau, H. (1995): Comparative effects of temperature and interrupted wet periods on germination, penetration and infection of ***Puccinia recondita*** F.sp ***tritici*** and ***P. striiformis*** on wheat seedlings. ***Phytopathology***, 85: 409-415.

Eversmeyer, M.G.; Kramer, C.L. and Hassan, Z.M. (1988): Environmental influences on the establishment of ***Puccinia***

recondita infection structures. ***Plant Disease***, 72: 409-412.

Eversmeyer, M.G. and Kramer, C.L. (1995): Survival of ***Puccinia recondita*** and ***Puccinia graminis*** urediospores exposed to temperatures from subfreezing to 35°C. ***Phytopathology***, 85: 161-164.

Falahati-Rastegar, M.; Manners, J.G. and Smart, J. (1981): Effects of temperature and inoculum density on competition between races of ***Puccinia hordei***. ***Trans Br. Mycol. Soc.***, 77: 359-368.

Falahati-Rastegar, M.; Manners, J.G. and Smart, J. (1983): Factors determining results of competitions between physiologic races of ***Puccinia hordei. Trans Br. Mycol. Soc.***, 81: 233-239.

Groth, J.V. and Urs, N.V.R.R. (1982): Differences among bean cultivars in receptivity to ***Uromyces phaseoli*** var. ***typica***. ***Phytopathology***, 72: 374-378.

Gulya, T.J.; Miller, J. and Rashid, K.Y. (1989): Rust races occurring in North America in 1988 and resistance of sunflower hybrids to races 1 and 3. ***Proc. Sunflower Res. Workshop***, pp 19-20.

Headrick, J.M. and Pataky, J.K. (1987): Expression of partial resistance to common rust in sweet corn hybrids at various host growth stages. ***Phytopathology*** , 77: 454-458.

Lal, T.B.B.; Mathur, S.; Chakravarti, B.P.; Singh, R.B. and Singh, R.D. (1980): Increase in sunflower yield by controlling rust with systemic and non systemic fungicides. ***J. Turk Phytopathology***, 9: 89-96.

Melching, J.S. (1967): Improved deposition of airborne urediospores of ***Puccinia graminis*** and ***Puccinia striiformis*** on glass slides and on wheat leaves by use of a turntable. ***Phytopathology***, 57: 647.

Melchers, L.E. (1931): A check list of plant disease and fungi occurring in Egypt. ***Trans Kansas Acd. Sci.***, 34.

McMullen, M.P., ed. (1985): Sunflower production and pest management. N.D. State Univ. ***Ext. Bull.***, 25.

Ouf, M.F.; Gazar, A.A.; Shihata, Z.A. and H.N. Soliman (1987): Some factors affecting spore germination, penetration and infection by maize rust. ***Minia J. Agric., Res.&Dev.***, 9: 1133-1149.

Peterson, R.F.; Campbell, A.B. and Hannah, A.E. (1948): A diagrammatic scale for estimating rust intensity on

leaves and stems of cereals. ***Can J. Res. (Sect. C),*** 26: 496-500.

Prud Homme, A-M and Sackston, W.E. (1990): Relative fitness of races 1(0) and 3(0, 1) rust (***Puccinia helianthi***) in mixtures on susceptible sunflower (***Helianthus annuus***). ***Can. J. Bot.***, 68: 1602-1608.

Schuh, W.; Jeger, M.J. and Frederiksen, R.A. (1987): The influence of soil temperature, soil moisture, soil texture and inoculum density on the incidence of sorghum downy mildew. ***Phytopathology***, 77: 125-128.

Sehein, R.D. (1962): Storage viability of bean rusturediospores. ***Phytopathology***, 52: 653-657.

Shaik, M. and Steadman, J.R. (1989): The effect of leaf developmental stage on the variation of resistant and susceptible reactions of ***Phaseolus vulgaris*** to ***Uromyces appendiculatus. Phytopathology***, 79: 1028-1035.

Shaik, M.; Dickinson, T.A. and Steadman, J.R. (1989): Variation in rust susceptibility in beans: predicting lesion size from leaf developmental stage measured by leaf age, length and plastochron index. ***Phytopathology***, 79: 1035-1042.

Shihata, Z.A.; Abdel-Latif, M.R.; El-Sadek, S.A.M. and Soliman, H.N. (1989): Viability of urediospores and chemical control of common maize rust (***Puccinia sorghi*** Schw). ***Minia J. Agric., Res. & Dev.***, 11: 739-757.

Shtienberg, D. (1995): Rational suppression of sunflower rust: Development and evaluation of an action threshold. ***Plant Diseases***, 79: 506-510

Shtienberg, D. and Vintal, H. (1995):Environmental influences on the development of ***P. helianthi*** on sunflower. ***Phytopathology***, 85: 1388-1393.

Siddiqui,M.Q.(1975): Identification of rust resistant cultivars in sunflower germ-plasm. Indian ***Phytopathology***, 27: 393.

Sippell, D.W. and Hall, R. (1982): Effects of pathogen species, inoculum concentration, temperature and soil moisture on bean root rot and plant growth. ***Can. J. Plant Pathology***, 4: 1-7.

Sivaprakasam, K.P.; Pillayarsamy, K.; Ganapathy, S. and Chidambaram, S. (1975): Note on the varietal response of sunflower (***H. annuus*** L.) to rust (***Puccinia helianthi*** Schw). ***Madras Agricultural Journal***,

62:2 (C.F. Rev. Plant Path., 55: 5867).

Velozhaban R.; Narayanasamy, P.and Jeyarajan, R. (1991): Reaction of sunflower germplasm to rust disease in Tamil Nadu. ***Indian Phytopathology***, 44(2): 239-241.

Walters, D.R. and Murray, D.C. (1992): Induction of systemic resistance to rust in ***Vicia faba*** by phosphate and EDTA. Effects of calcium. ***Plant Pathology***, 41: 444-448.

بعض العوامل المؤثرة على التفاعل بين نباتات عباد الشمس وفطر الصدأ (*بكسينيا هيلينثاى*)

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قسم أمراض النبات – كلية الزراعة – جامعة المنيا – المنيا – مصر

تاثر التفاعل بين نباتات عباد الشمس وفطر الصدأ تأثرا واضحا بعدة عوامل أهمها طريقة العدوى ، كثافة اللقاح وسطح الورقة ، وعمرها ،ورطوبتها ، أصناف عباد الشمس المختبرة ، وحيوية الجراثيم اليوريدية ، فترات تعريض العائل للإضاءة خصوصا بعد إحداث العدوى . وبلغت شدة الإصابة الناتجة عن العدوى بطريقة طلاء الأوراق بالجراثيم ٣-٦ أضعاف تلك الناتجة عن أحداث العدوى بالرش أو تعفير الأوراق بالجراثيم على التوالى .

كان السطح السفلى للورقة كان أكثر قابلية للإصابة من السطح العلوى . وكانت الإصابة متضاعفة على السطح السفلى كما أظهرت الدراسة علاقة عكسية بين شدة الإصابة وعمر الورقة.

صنف جيزة ١ هو أكثر الأصناف قابلية للإصابة يليه الأصناف المصرية الأخرى جيزة-١٦١ ، جيزة-١٥١ . بينما كان الصنف مياك والهجن اقل قابلية للإصابة .

كان لفترات الإضاءة تأثيرا واضحا على إصابة عباد الشمس بالصدأ . مع وجود علاقة عكسية بين فترة الإضاءة وشدة الإصابة خصوصا إذا تعرضت النباتات لفترات إضاءة أطول بعد العدوى الصناعية .

إنبات وقدرة الجراثيم اليوريدية للفطر على إحداث الإصابة تاثرت بالحرارة ، الرطوبة ، بإلتصاق الجراثيم بنسيج العائل وبفترة التخزين . إزداد الإنخفاض فى الإنبات والقدرة المرضية للجراثيم اليوريدية بزيادة درجة الحرارة وطول فترة التخزين خاصة تحت ظروف الرطوبة العالية للجراثيم الحرة "المفصولة من العائل" .



and detailed characterization of this strange experience (except perhaps Einstein in some suggestions of his).

3. These considerations help to understand,I believe, that Science may assume the role of a superperson as has been described in sec. I. further above. Indeed, in order to assume it, it must afford both possibilities of theoretical and practical nature, for the human nature does have these two components and is never content if only one is involved in the fulfilment of human life: Man is not only home sapiens, he is homo faber too. He thinks and he works; his reasoning must be completed by action, and his activity sustained by reason.

The cases of the Church and the State illustrate this. They are both institutions incorporating each a fundamental activity of man, religion and politics respectively (see further below the slight distinction to be made).

Politics may stand for morals in a certain sense: The State is a main realization of morals through the channel of politics. It has an abstract background founded on some theory of law and explicated in charts and other constitutional texts; it has a concrete basis in all the institutions like parliament, government, court, ministries, secretariates, schools... In certain countries, the adopted system is such that nothing of the life of the community is private, on the contrary everything is common, it is a concretization of the ideal of communism,. Another concretization might also integrate everything, though in a different way, viz. a State of absolute monarchy where the monarch disposes of all. Both cases are extremes for which the theoretical background degenerates into a doctrine encompassing every possible situation, with the consequence that practice does as a corrective not interact anymore with theory (the doctrine) and in a mutual connection of reason and experience. Power is here usurped by theory, and its application is rendered arbitrary even if abstractly consistent. Anarchy, to take another extreme, is seldom realized as the state of a State, but if it were, it would amount to the ignorance of reason and consequently degenerate into the concretization of pure experience without any understanding; this is the renunciation by man to act as *homo sapiens* and therefore the usurpation of power by something like instinct or pure will.

The Church is a realization of religion in the community of men. It has an abstract background resting on the acceptance of dogmas which work like axioms of a more or less elaborated theology, and it finds a concrete

realization in all the practices like rites and their performance by priests within various material conditions. Extremes are also known. For instance the Quakers or members of the Society of Friends drop so to say all the theoretical apparatus and live in religion as if in a pure experience, allowing in a sense for a complete anarchy in the sense where anarchy means the absence of leadership, i.e. the absence of power (here of theoretical power). Another example is to be found among hermits; but hermits may have to wait for tame birds to bring food and share it with them. At the other extreme, all forms of scholastic–should I say scholastism? – tend to ignore the religious experience and to plunge into mere abstraction, which also an usurpation of power, however, *mutatis mutandis*, an usurpation by theoretical reason, allowing for an arbitrariness against which the mystics have always reacted.

These comparisons justify, I believe, the kind of prediction made at the beginning, making it more than an expectation or a presentiment, viz. that Science will indeed be in a position to fully succeed the State in assuming the tasks of leadership, both practically and theoretically, of mankind. But there remains the difference consisting in the fact that Church and State are institutions, whereas science like religion and morals are proceedings of the human mind, and politics (between morals and the State) is a procedure. Between religion and the Church, we could name the cult as a procedure analogous to politics.

What are then–we might ask–the procedure of science and its institutionalization, analogous to politics or the cult and to the State and the Church? One might be tempted to identify the procedure of science with Technic. However, this would not do. For, technic does not arise within a single proceeding of the human mind, but in an encounter of two such proceedings, mainly between science (or a science, or a part of such) and morals (or a part of such), in which both partners have to come to a mutual equilibrium and to proceed along a common and combined procedure called Technic. So the procedure of science is to be looked for elsewhere. In fact, it is found in the very participation of men engaged into the development of science: By this participation, these men find themselves filled with a satisfaction because by science, they know more and they can more; it is an enlightenment comparable with what was meant by the Encyclopedists of the French 18th Century.

Yet, finally, if I were asked: who is the super-person who does, now, or will, later, embody and perform science, like the State embodies

morals through politics or the Church performs the cult for the sake of religion. I must confess that I would be at a loss. This super-person or body is not (yet) visible. In old days, scientists gathered into academies; there are also in our days institutes of advanced study beside university departments. We may still be in a situation comparable with the one reigning at the beginning of the rise of the State, when the manifold of principalities, republics and other units did not yet integrate into the body of a conceptual State. The communist countries have already replaced the disused conception of old-fashioned academies by a completely new one in which all scientific research *qua* research (in contradistinction to teaching science) is done in its various divisions, whether pure or applied, for they make no difference. In that sense, such academies of research are like armies; their head scientists are comparable with active officers of high rank. Only, up to now, scientific service, in contradistinction to military service, is not (yet ?) compulsory. Officially these academies stand still under the control of the state; actually, they begin to control the state, and often the leaders of the state (of the "party") have arisen out of the scientific career, say, out of the "academy" as if Plato's claim of a State ruled by philosophers would come into being.

Who knows what will follow and how the workings of the new super-person will be organized in the year 2000 ? Let us just hope, that it will neither degenerate into scholastism nor claim sole authenticity and authority over human conduct.

4. I might stop here, in the assumption that what has been said talks, on the one hand, for itself thanks to the sober nature of its exposition. Yet, the inevitable imperfection of my presentation might, on the other hand, awake among the readers or listeners the impression that I approve of something like the totalitarian impact of Science upon human life, and that I rejoice in, the prospective that Science will lead, that it is "good" so ... in short that I am an adept of scientism.

Nothing would be more wrong than this latter interpretation. Anyone who has had the opportunity to read some of my works knows that on the contrary I have always pleaded for a well balanced flourishing of all human possibilities, and if I may remind of it here, the theory I advocate assumes that science is not more than one of the four cardinal enterprises of the human spirit; the other ones are of artistic, of moral and of mystic nature. So, from the point of view of my theory of knowledge, it would be necessary, for one to be comprehensive, to develop a critical analysis of the situioen

described further above, followed by an evaluation of the consequences it may have as well as by an estimation of the possibilities and chances of weighing down such eventualities as might have been shown by the critical analysis to lead to some sort of degenerate situation.

However, I shall not attempt to do it here, because I should have to repeat too much of what I have expounded in earlier publications.

In short, it would require the exposition of a theory of knowledge which begins by separating man as a subject which is being judged upon, from man as a subject who judges by himself, yielding two fundamental modalities : A modality through which knowledge is obtaind inspite of a refusal of judgement (by the subject), and a modality, called modality of judgement. The first modality identifies itself with mystic knowledge and is as authentic as any of the modes of the other one. Then, the second of the two fundamental modalities allows – for reasons which will not be repeated and analyzed here– of three modes, viz. objectivity or the scientific mode, subjectivity or the mode of art, and communitivity or the mode of morals. 1

Now, precisely – and this will serve as an abrupt conclusion: If a Church claims to endow the first of the modalities alone with authenticity and authority by the adoption of a totalitarian system of dogmas and practices, it simultaneously destroys arbitrarily the autonomy of the modes of judgement and is due to degenerate into scholastism and to render in the long run spiritual and practical life unbearable.

Exactly the same applies if one single of the modes within the modality of judgement makes the same claims: The State has finally done so along the mode of morals; the superperson embodying Science may go so far along the objective mode and fall into the same mistake.

Objectivity has its limits. It is not the prime and sole criterium of wisdom, but one among a few others. Whoever ignores or contends this, is himself ignorant and lacks education. He may never know, what tolerance is in the most comprehensive and generous sense of the word.

1. These things can be read e.g. in one of the following books: A. Mercier, *Thought and Being, An Inquiry into the Nature of Knowledge* (Basel 1959), A. Mercier, *De L'amour et de L'etre, Essai sur la Connaissance* (Louvain et Paris 1960), A. Mercier, *Erkenntnis und Wissenschaft* (Bern und München 1968), A. Mercier, *Science and Responsibility* (loc. cit.)

TIME, THE CONCEPT OF GRAVITATION AND THE POSSIBILITY OF A UNIFIED FIELD THEORY

ANDRE MERCIER

SUMMARY

Is there a fundamental reason of a physical nature to look for a Unitary Theory? Yes, for the various known independent interactions allow each for the construction of a watch, each watch indicating a specific time with its proper unit based on a periodic phenomenon. Experiment shows with tremendous accuracy that if one of these periodic phenomena is declared regular, the other ones are also regular, which implies a Unitarity of Time.

Special Relativity, as well as General Relativity, should not be said to replace a 3-dimensional (so-called Newtonian) space by a 4-dimensional one. What they do is to replace a one-dimensionally structured time by a 4-dimensional one with a light-cone structure. Now since, in GRG, the structure of that 4-dimensional manifold is determined by gravitation and the said manifold is time itself, Time and Gravitation are 'identical'. Hence gravitation is not an 'interaction' like the other interactions'.

It is also doubtful, whether gravitations exist. If they do, then quantization of gravitation would amount to a quantization of time.

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* This lecture was delivered on December 22, 1976.

1. The following dilemma arose and will presumably not be solved before the end of the nineteen seventies.

On the one hand, lots of good physicists are engaged in the observation of what they call "gravitational signals". Even if no one can say that such signals have been registered with certainty, the arguments in favour of a satisfactory observation in due time seem extremely convincing.

On the other hand, General Relativity strictly speaking does account neither for a clear notion of energy, nor for a rigorous propagation of waves, Even the analogy between gravitation and electromagnetism is utterly criticable

What is it then we are talking about when we call it gravitational signal ?

2. There are periods in the development of physics when the received views do not quite fit into the correct description of Nature. Perhaps we are in such a period, because we are still used to interpret the observations we make by means of concepts and representations proceeding from a philosophical background elaborated by a generation of physicists who were faced with problems different from ours and issued from difficulties that we are not expected to overcome any more.

So, maybe it is not all too "mal placé" if I permit myself to behave like a naughty boy and try to contend many a received view and see what happens. Probably the reader will find me crazy, but Niels Bohr was once of the opinion that one never may be crazy enough, except very exceptionally.

For Bohr knew that a time would come when all our opinions would have to be in their turn completely revised,—as completely indeed as he himself and Albert Einstein had revolutionized the current **WELTBILD.**

3. 1974 in Erice, I gave three seminar lectures on Cosmology from an epistemological view point . In these Erice-lectures, I started from the fact that cosmology intends to be the theory of the world as a whole and that according to Einstein its only truly universal property is gravitation. If we then make a geometrical picture of the world, the fundamental structure of its geometry must allow for our interpretation as gravitation.

I have also given the reasons why I think that gravitation is not an interaction like the "other" interactions. One problem arises here specifically. When fields are quantized, their particles are found to be the bearers or transmitters - one might say even the propagators–of the interactions between other fields, and a systematic classification can be drawn from their consideration. For that to be successful, however, the quantization must assume

the linearity of the field theory and-imply consequently a superposition principle for the corresponding waves.

4. In a certain approximation, there are gravitational waves. At least this is a possible interpretation of the formal aspect of the Theory. Hence, in so far as gravitation is interpreted as a field in the usual sense, there should–people say–be gravitons by straight-forward quantization within the said approximation. Since gravitation is the most general, i.e. truly universal property of matter, gravitons would then be the most fundamental particles.

However, apart from their being practically unobservable, such gravitons are very much different from the particles of other fields; the only similar property they have to other particles is a spin : a spin of 2. But a spin of two seems to me highly improbable for the particle which ought to be the most fundamental of all particles, or rather : the fact that will-be gravitons have a spin 2 is only the consequence of an artificial construction of those particles, but their construction is unrealistic, at most formal, and perhaps we should do better to forget about them, i.e. to refrain from quantizing an artificially linearized assumed field of gravitation. This would mean that the so-called field of gravitation is not of the same nature as other fields like the electromagnetic one and that all the analogies used in reasonings are no other than formal analysis.

Another reason to doubt that gravitons exist is that if they did exist, they would have, on the ground of Einstein's non-approximate, i.e. complete equations, to themselves emit and absorb gravitons, precisely because of the non-linearity of these equations, and I find this as hard to believe as it was difficult for Newton's contemporaries to believe in the immediate, infinitely quick propagation of the effects of gravitation through arbitrarily long distances in space.

5. One has been much influenced by the idea that physics is fundamentally a quantum physics. However, the original part of physics which was submitted to quantization was electromagnetism alone, first by means of Planck's oscillators leading to Einstein's photons, as well as in the form of old quantum theory, then n the form of classical quantum theory and, finally, as quantum electrodynamics. Only after this, did quantum field theory actually arise in the mind of people as the general form of physics and as yielding the possible definition of particles as quanta of the various fields. This situation was similar to that of Newtonian mechanics becoming the

accepted form of physics after having been conceived by Newton originally as a theory of gravitation only.

Indeed, the success of Newtonian and post-Newtonian mechanics was such that physicists came to believe that every physical theory had to be elaborated in the same form. The only exception to that belief was thermodynamics, and there is no doubt that Carnot, who must be considered as the founder of thermodynamics, even if he was partly inspired by comparisons between the flow of heat and the flow of fluids, did realise that a complete different approach to Reality was necessary if he was to explain unsuccessfully the dissipation of energy (though he did not use this modern terminology). And statistical mechanics did not reduce thermodynamics to mechanics, it only showed how to introduce micro-mechanisms into the description of (macroscopic) engines.

Newtonian mechanics was an atomic view on reality, since it started with point masses. Only by the consideration of Euler and Lagrange on fluid as quasi-continuous assemblies of particles or rather conversely the quasi-atomic analysis of fluids as distributions of mass, the infinitesimal elements of which behave like point masses - was it possible to develop a mechanics of continuous media similar to what later has been called fields. However these media were not endowed with independent properties that would make out of them entities of their own, i.e. proper fields. The only necessary supplementary postulate was the assumption that their stress tensor is symmetric else the conservation theorems cannot be demonstrated. (Originally, conservation principles were admitted and the symmetry of the stresses deduced.) Only when Faraday conceived of the magnetic and electric fields as independent physical realities was the concept of a field made available to physics.

6. If we now look at Relativity Theory, we notice that two view points may be taken, as I have repeatedly explained. Either things are defined as world-lines, or there are no objects but fields. I am tempted to say that there is kind of complementarity between world-lines and fields, and that consequently it does not make good sense to consider world-lines embedded in a field.

6.a In the world-line picture, as I have explained in the Landé Jubilee Volume, the objects of physics are subject to what I have called super-determinism, for since an object is identical with its world-line and each object simply is as it is by its own right so-to-speak, nobody disposes of that object, for its world-line is a necessary part of the world which itelf consists of nothing

but invariable world-lines and it makes no sense to pretend that we are able to let any world-line go through a particular point of space-time, which is an event, chosen in the sense of an initial condition, for we do not have any power or disposal over world events, whereas in Newtonian mechanics, we are allowed to choose, – we must even give, – the initial conditions, which is a certain and precise, though limited, freedom of the will, the limitations of which lie in the second order of the differential equation of Newtonian dynamics. There is no such free will in the second order of the differential equation of Newtonian dynamics. There is no such free will of Newtonian kind in Relativity Theory, unless it be made completely artificial. Laplace, conversely, made Newtonian mechanics artificially completely determined, but Laplacian absolute determinism does not follow from Newtonian mechanics; it is valid only under the further assumptions, first that all bodies without exception, (i.e. including people like physicists) evolve according to Newtonian mechanics only and second that the world was created once for all, whereas the relativistic picture of world-lines includes the invariability of the set of all world-lines and is therefore the picture of a huge four-dimensional fossil that has always been a fossil.This picture does not fit very well in our physics.Indeed,does not our physics rest on the assumption that observers receive signals if they **chose** to stand at the right place with the right instruments to capture them ? Therefore, (6.b), the other alternative, i.e. the picture of fields is presumably the more suitable one. This is exactly what relativistic electrodynamics revealed in its special relativistic form. The interesting thing is that after its generalization, Relativity Theory did not attribute any more to the electromagnetic field the nature of the fundamental field. Actually, this is not so very astonishing, for the fundamental field (I call it still a field for want of another better name) should not be one which transmits a particular interaction, especially if other fields are at hand in the usual sense, capable of a quantization and of the attribution of various kinds of charge. The fundamental field is gravitation. and has no specific property other than that of being the fundamental field As a matter of fact, the only features of that field are first its admitting of null-lines and hence null-cones locally, and second its being the consensus of all Matter.

7. At the time of Newton's and during a couple of centuries since obseved signals were always and on a world-wide scale only light signals, or eventually sound where there was an elastic medium, but that latter case is of minor importance and even not relevant, since in the atomc picture there is only vacuum between the point masses. In principle, all celestial bodies would

have to immediately change their position and momentum if I chose to move my hand even just a little bit, and this does not provide for any practicable signalisation. On the contrary it produces a permanent disturbance.

Indeed, are signals which are instantly transmitted real signals ? Can they be anything else than the built-in synchronism of ideal clocks devoid of reality at the various places of a Newtonian world, i.e. the material aspect of the assumption of a universal and absolute time ? So the question arose, whether there can be gravitational signals.

This question is not only a question of Newtonian mechanics where it always sounded more or less meaningless or unbelievable, but also one of General Relativity. In General Relativity physics, such signals would of course travel with the limit velocity c, which was found very satisfactory and helped overcoming the old difficulty. In that respect, the limit c needs of course not be just the velocity of light; on the contrary, it is primarily the limit velocity which defines the null-lines, i.e.,–experimentalists might say–the velocity of any signals properly speaking, though I personally would rather as the value of a universal constant to be necessarily used as natural unit of all measurements of velocities, which is important enough. From that view point, it does not appear necessary that there should be gravitational signals, especially if gravitation,–as I have explained in the Erice–lectures,-is nothing but the material aspect of time, for, as I argued, spacetime is not to be considered as a space, but as time itself endowed with a richer structure than Newtonian time. In that case, the so called gravitational field would not be a field proper, i.e. a function of space-time, but space-time, itself, whereas proper fields would arise from the specific behaviour of matter due to certain of its properties, and only such specific fields could be used for the transmission of signals, because they would admit of some quantization and eventually transport well-defined amounts of energy in some ordered shape, which are the conditions for signals first to be paid for, second to be understandable.

8. So the question should be asked at this point whether assumed gravitational signals would only be noticeable or rather make sense if and only if some sort of quantization of gravitation would succeed. Yet serious doubts may arise in that respect, for if that quantization succeeds, the next question is: would it be comparable with ordinary field quantization? Precisely this can be doubted, for apart from the fact that it should be done with full respect due to the non-linearity of the field equations, a further difficulty seems to arise from the fact that the very gravitational picture of modern

physics is not really a local picture, but a global one (though Einstein's original application of differential geometry was only local). The necessity of a global picture was realized, I believe, by various scientists after the second world war, e.g. by Michel Kervaire and myself when we prepared together the Golden Jubilee of the Theory of Relativity in 1955 and discussed the matter then. The reason I would give for that is, that Relativity physics really is to be a cosmology, not a local engineering-like attempt at getting at individual things like test particles or singularities, which are both rather unphysical, though they do work very well in cases like the motion of the perihelion or the description of black holes. The fact that Relativity Theory is a cosmology, however, makes, it seems to me, a quantization in Bohr's sense illusory, for there is no observer outside the cosmos and this seems to me in a way pretty evident: How could we indeed look at the cosmos from outside since we are inside ?

9. At the 1955 Jubilee Conference, the possibilities and difficulties of quantizing gravitation were already under discussion, especially in a paper by Eugene Wigner. Twenty years of effort have not led to much progress. For the problem solved in the meantime, mainly by Lichnerovicz, viz. to express quantization recipes in a generally covariant manner is not the proper question to be really put. The problem is to quantize somehow the seemingly unquantizable gravitation. At a time, much attention was given by Dirac, Bergmann and others, to the homogeneous canonical formalism because, fundamentally, Schrodinger's equation is nothing but the analogue, by the principle of correspondence, of the so-called accessory condition of that homogeneous formalism. However, could such consideration lead to more than the unnecessary quantization of the state of a non realistic test particle ?

According to recent attempts at a global approach by means of symplectic mechanics using space and co-tangent space, it seems that some sort of quantization may succeeed. But I wonder whether it will then be one similar to the quantization yielding a spectrum of possible states in which the system under consideration can be found by observation. or whether it will rather be the imposition upon the world of something like an inherently discontinuous structure endowed with minimum cell measure of a lattice or the like, comparable to cells of measure h" in phase-space. This would be very different from field quantization, and at the same time very nice in two or three respects, for it would yield the missing elementary universal constant ot be used as a natural unit, and possibly define at the same time a universal

clock built in the universe and available "at every event-point", which is what is desirable, since space-time is in my view time itself and should not depend upon the choice between different kinds of clocks based either on gravitation like old kitchen clocks and the motion of the Earth on the ecliptic, or on electro-magnetism like wrist-watches and atomic clocks, or on the life-time of radio-active substances etc. Finally, it could perhaps explain why gravitation appears to be a macroscopic effect analogous to statistical description of nature.

However, this would not at all be quantization delivering quanta of a gravitational field,–gravitons, - and therefore it would neither support nor contradict the idea that there are gravitational signals similar to waves and packets of such. Waves would then at most be lattice waves of the 4-dimensional space-time, i.e. something like fluctuations in time itself, whose observation could only be made eventually in comparison with real clocks, but not with ideal clocks.

The fact that so far no gravitational waves or signals have with any certainty been observed does not prove that there are no such signals. For these signals, if they exist, may be too weak to be noticed by means of our devices. Yet, it may be an indication that gravitation is not that what some think it to be. I should like to insist however that even if the attempts at observing these signals have so far not led to conclusive results, the idea behind them is perhaps still more important than was imagined by those who started them.

10. Indeed, we can never know what are the most important or crucial problems of the physics just ahead of us. If we remember for example the origin of quantum theory, who would have dreamed in 1900 that the solution to the difficulties to explain the energy distribution of the black body would open such a revolution ? or that the fact of Maxwell's equations not being Galilei-covariant would start Relativity physics ? In both cases, the available theory was to become obsolete or eventually a mere approximation: that is quite a warning. Perhaps either Quantum theory even in its most advanced form of quantum field theory, or General Relativity, or both, are to become obsolete or approximate. Indeed, why should a theory that was made for the electromagnetic quantum field be the right one for other objects, especially since it already is unable to satisfactorily get rid of its infinities ? And why should a theory meant to reintroduce the description of gravitation lost in

Special Relativity, be exactly the correct grasp of the very fundamentals of time, i.e. of the independent parameter upon which all further functional description of the properties of the world and its constituents depend ?

The sort of argumentation I have used could also be applied to a discussion of the question whether a unitary field theory makes sense. I shall not touch it. It would lead to far reaching considerations about the nature of physical interactions as well as about the very question: what is meant by the unification aimed at–a question upon which I have dwelt elsewhere. So let me rather conclude.

11. I know that I have presented no single positive result, and that I have been speculating in a way that will sound very unphysical to many a physicist! Actually, I have done something quite different : This paper has been conceived in its very methodology as a continuous questioning: I have successively questioned the received views, especially on the existence or reality of consumed physical entities. This procedure of doubting systematically propositions just uttered in order to get at successive insights into the nature of things is typical of a philosophical method known as phenomenology. The idea of systematic doubt goes of course back to Descartes; but there it was just doubting the received views, whereas phenomenology to-day as it was conceived by Husserl is a methodology of its own. In a way, if one pleases to say so, I have developed these considerations precisely in the form of an exercise in phenomenology, with the purpose of finding out, how far a philosophical method like that can be seriously applied to a scientific field sufficiently familiar to me: an experiment in philosophy, if you will. Looking back at it, one can say, it seems to me, that the experiment has been successful in its own right. For it has shown that it makes perfectly good sense to analyse an important (though not uncontroversial) piece of physics by means of the phenomenological method,

THE PLATONIC DIALECTIC
AND
THE ARISTOTELIAN CRITIQUE*

JOHANN ZOH

The path that leads a philosophical inquiry into the ultimate meaning of thing is not a wide path It is a narrow, lonely path. Moreover, it is one which the philosopher finds, to his great perplexity, quite often impassable. Driven into such difficulties, his immediate task should be to make the impassable path passable. However, should he, realizing the path he has chosen hard to follow, decide to try out another path that appears to be available to him, he would quite possibly be straying into a maze from which he could hardly expect to get himself out again. Plato said that a philosopher should, first of all, devise a methodology, and that it only befits a philosopher to do so. When no such methodology is devised and employed, philosophy will fall into an utter chaos. Indeed, it will be reduced into something that is quite unworthy of that name. By methodology Plato meant the 'following of path'. Plato, since his middle period, used a metaphorical expression 'hodos', meaning 'path' or 'way'. This path he chose for the purpose of philosophical inquiry was the dialectical method.

It is by no means a path whose surface is even. Moreover,it is a winding, circuitous path that must constantly search itself out. Most of all, it is a path where the travelling companions 'together accumulate' ('collect together') logos as they go along, and, as such,.. it is worthy one to follow. Plato observed: "Dialectic...does stand as the copingstone of the whole structure; there is no other study that deserves to be put above it." (Politeia 534e).

Then, is the dialectical method Plato adopted the only path of philosophical inquiry worthy of that name ? Of the modern philosophers, it was Hegel who thought it was the only and exlusively valid path for such enterprise. Hegel noted that "dialectic," that is, "the great methodology" Plato employed in the strictly academic discourse, "constitutes the moving soul of scientific progress, and is the principle through which alone immanent connection and necessity enters into the content of science". The path of philosophical inquiry is not a path that is smooth and well-ordered. nor is it one that is lit with signal lamps at regular intervals. On the contrary, it is a narrow,

* This lecture was delivered on December 12, 1977.

strait path envelopped in thick mist where one can barely find his way. It is a path fraught with many difficulties and where one is constantly being thrown between the two extreme poles of certainty and doubt. Here, with his dialectical method, according to Hegel, Plato showed us the way of circumventing such difficulties.

However, Aristotle, Plato's disciple. did not consider the dialectical method perfect or full-proof as a means for attaining knowledge. He noted that so very often in a dialectical discourse, as in everyday dialogues, elements other than those pertain strictly to the given subject, are likely to enter, muddling the process of reasoning and, thereby, leading us to a false conclusion. Aristotle also noted that dialectic cannot be the kind of "reasoning that necessarily results". and that "it reasons from generally accepted opinions" In other words, it is not "the demonstrative reasoning that proceeds from premises which are true and primary", and, as such, it is a defective method of reasoning For Aristotle, the search for knowledge should be characterized by reasoning this dialectical search for principle ends, that the inquirer (the philosopher) attains his final goal and destination, "the world of form". However, that we have to keep in mind is that, although his method is couched in the "question and answer" form, unless the main subject in pursuit of the same problem is constantly kept in sight and maintained, dialectic fails as a philosophical methodology. According to Plato, two styles of dialectical discourses are possible: one is the kind adopted in the courtroom for defense argument by which one's position and points of advantage are zealously guarded and advanced against the prosecution, the other being one by which both participants of the dialogue with opposing views, not entirely convinced in the validity of their respective positions, co-operate in search of the ultimate answer. The former is called 'eristic' which is the form of argument often exploited by those disputants who unscrupulously posit false statments and theories. Of these two, it is the latter which is the truly 'dialectical' way that can guide the opponents to the true path of philosophical inquiry. (Theaitetos 167e – 168a).

Accordingly, a self-serving attitude is an anathema to the dialectical method. The truly dialectical way does presuppose neither the 'truth' nor the 'falsity' of the view advanced either by the position of thesis or by that of antithesis, since their contrasting positions are expected to unite in spirit in pursuit of the final answer. As Plato observed, one who partakes in a truly dialectical discourse is not like one who partakes by logical discourse. And, therefore, it needs to be equipped with an adequate tool of reasoning. Without

being equipped with such tool, Aristotle noted further, an inquirer "does not know where he is going; besides, one does not even know whether the thing required has been found or not. To such a man the end is not clear." (Met., B, 995a) In short, what Aristotle emphasized, offering us as the alternative, was the analytical logic. This is the "wherefore" of the Aristotelian logic.

It was Kant who whole-heartedly accepted the Aristotelian position. Kant's **Critique** pursued"the transcendental logic" which precedes, and is the basis for, all forms of experience. It also distinguished the analytic from the dialectic. Kant assigned to the former the task of clarifying the basis of all inquiry into knowledge, while calling the latter rather disparagingly as a kind of sophistry or, "the logic of illusion," (A 293/B 349) which with deceitful intention contrives to give a mere appearance of truth.

Today, I propose to treat as objectively as I can the issue of the dialectical method as a valid means for philosophical inquiry, and, thus, intend to give a re-examination of our attitudes toward it.

As has already been mentioned, the dialectical method as such started with Plato who recorded his own philosophy in a dialogue form. No doubt, he emphasized the efficacy of this method through his entire philosophical career as the style of his works,

Plato believed that it is where the path of "shophist of eristic and contentious sort", since its participants are "friends and choose to have a discussion together, and they should have to reply in some milder tone more suited to dialectic". (Menon 75d).

Plato adopted dialectic as a means for philosophical inquiry under the influence of Socrates. In his pursuit for truth, Socrates had to cope with those sophists who adopted the method of "double arguments", according to which they could similarly prove and disprove the truth of a thing with the same manner of argument with equal facility. In dealing with these sophists, Socrates let the questioner, who alternated questions with answers, employ the art of 'elenchus' by means of which the questioner could drive his opponent into a self-contradiction. With this method, Socrates chose to get out every bit of ground and excuse from the opponent's contentions for the purpose of attack. It may be that Socrates inherited this method of discourse from his mother, Phainarete, who was a midwife. His method, indeed, may be called a kind of "midwifery". The duty of a midwife consists in helping a woman deliver a baby. Her job is to help relieve the expectant mother of the birthpains she is undergoing by use of medication

or, at times, when it is necessary, by giving her an abortion. Socrates, who applied his mother's midwifery to the philosophical inquiry into truth, considered it his duty to help out "the ignorance of a wise man" with his art of spiritual "midwifery". In other words, as an intellect of the ignorant he wanted to test the validity of other's assertions by use of dialectic and thereby, help him arrive at truth.

"By the reason of search" Socrates tried to lead others to discover truth. (theaitetes 210c). Plato thought the Socratic method could surely bring about the right kind of philosophy. By means of rhetoric, the sophists made the false appear true and the true false. And the rhetoric they employed was either the method of 'paradeigma' which made use of examples ("it is . . . both in the case of A and in the case of B") or the method of 'enthymemes' (for instance,"one who is jealous hates"), that is, a thing that is possible. There is, however, frequently, the third kind of case which is neither A norB. One who is jealous does not necessarily hate, for he is jealous out of love. Therefore, it is possible to say: "one who is jealous loves" The Sophists' design was to display as truth what is in fact false by means of equivocation. Their kind of rhetoric was not intended to arrive at truth proper. For them it was primarily an art of persuasion which they used in order to win in the eristic game they enjoyed playing. These sophists managed to introduce into the dialogue elements which do not belong to the subject proper. In this manner, they contrived for word-trick. This rhetoric was originally regarded as "the ghost or counterfeit of a part of politics". (Gorgias 463d).

Aristotle viewed, however, that one must not consider the Platonic dialectic a panacea. It is true that he acknowledged the usefulness of the dialectical method where the business of 1) intellectual discipline,2) one's debate with one's opponent, and 3) the acquisition of philosophical knowledge are concerned, But, at the same time, he was critical of the method for being unreliable as a scientific means of verification. Of course, it is different from the art of sophistry and, in a sharp contrast to the latter's falsity, it is in possession of a kind of examination. Also, in terms of the purpose of the philosophical life, it has nothing in common with the art of spohistry.

Aristotle viewed that, although it is true that the dialectical method develops an argument "by way of contradicting the contrary of established opinions", it still starts from the tendentious observation of facts and does not proceed to reason with necessary evidence. For instance, the saying that one must be

good to one's friend is gnerally interpreted to mean that one needs not to be good to one's enemy. However, this kind of reasoning shall, of course, have to be re-examined by the principle of obversion of the formal logic. The proposition must be dealt with by means of inference by necessity.

The dialectic, as in the case of the Socratic irony, possesses what may be called the "negative capability", and, since it pays a special attention to what is absent, it can play a significant role in the business of verification. "However, dialectic does proceed by interrogation", noted Aristotle, "whereas, if it aimed at showing something,it would refrain from question, if not about everything, at any rate about primary things and particular principles". (De Sophisticis Elenchis 172a) Although the dialectical method extracts from the opponent an answer either in the positive or negative and, thereby, develops an argument, there are cases in which an argument conducted in such manner can go only so far, beyond which it is not possible to make any further progress. In cases such as this, it is necessary to establish a basis upon which one can continuously, without being interrupted, develop the argument. This will be possible by formulating general principles with common applicability rather than a principle geared to a specifically limited purpose. Such ground constitutes the "common premise", which serves as the basis for the Aristotelian logic.

For instance, whenever there was a rainfall, the earth is wet; therefore, whenever one finds the earth wet, one may hastily conclude that there was a rainfall. This is to commit the error of "making a conclusion through argument based on symptoms". Accordingly, it cannot be a "necessary" conclusion. Aristotle thought that it is possible for one to commit such error when there is no notion of the "middle" ground. When there is this notion of the "middle", one can derive the apodeictic modality (... must be) in distinction from the assertoric modality (... is) and the problematic modality (...probably is). That is, one derives the mode of inference by necessity in the propositional form of "if A belongs to all B/ and B belongs to all C/ then A belongs to all C" At the time when the distinction between psychology and logic had not been made, Aristotle made not only that distinction, he also perfected syllogism which was the final fruit and mainstay of the formal logic.

But, then, are all our philosophical inquiries to be pursued solely (exclusively) by means of the Aristotelian analysis and inference ? Athough Aristotle's logic neatly formulated the rule for all forms of proposition, that is, the rule, according to which it can be determined whether a given proposition is "universal" or "negative", its efficacy tends to be confined to the kind of inference that is more or less mechanically oriented. I view that the separation between "the dialectical syllogism" and "the demonstrative syllogism", as in accordance with the Aristotelian classification does hamper and impede the productive capacity of the philosophical inquiry. Aristotle's criticism of the Platonic position which held the dialectic as the one and exclusively efficacious method applicable to all forms of philosophical inquiry is quite valid. However, for the philosophical knowledge concerning the world of being, observable and penetrable not through the sense perception but through the eyes of intellect, "the logic of demonstration" should offer its own foundation (which it has established for itself) to the dialectic method for a philosophical inquiry. I believe, indeed, that it is only when the demonstrative method of Aristotle and the dialectical method of Plato can have a meaningful co-operation and complement each other that the goal of our philosophy in terms of its productive capacity will be fully attained at last.

MOUVEMENT MUSICAL ET PSYCHOLOGIE DANS LES DERNIERS DIALOGUES DE PLATON*

E. MOUTSOPOULOS

Bien que dans le *Phédon*, Platon semble rejeter la conception métaphysique de l'âme-harmonie, il accepte dans la *République* la conception psychologique de la structure musicale de l'âme. Cette conception; encore confuse dans les dialogues de maturité est précisée dans les derniers dialogues du philosophe par l'introduction de la notion de mouvement musical qui se rattache à la catégorie du mélange des contraires, et des médiétés, par le fait même qu'il constitue un trait d'union entre la matérialité de la nature du son et la spiritualité de ses effets sur l'entité humaine. Le rapprochement des notions d'âme et d'harmonie effectué dans la *République* se renouvelle sur un plan cosmique et absolu dans le *Timée*, où le rapprochement de l'aigu et du grave s'effectue non pas par leur suppression réciproque dans l'unisson, dans le *Philèbe*, mais par leur affirmation dans une impression fondue. Les sons envahissent les sièges des trois parties de l'âme humaine; tout en subissant un ralentissement implicite, proportionnel à leur vitesse et à leur hauteur initiales, avant de mourir, ils imprègnent l'homme du modèle idéal d'harmonie. Leur mouvement régularise les mouvements naturellement désordonnés des êtres vivants, tout comme l'harmonie régularise les mouvements désordonnés de la matière qui constitue l'Ame du Monde. Dès lors, ce principe peut être appliqué à l'éducation des enfants et à la guérison des états corybantiques. Le mouvement musical constitue une résolution des antinomies existant entre le matériel et le spirituel. Médiété polyvalente, il assure la continuité entre l'essence et les principales manifestations sensibles de l'humain.

Dans le *Phédon*, Socrate refuse la thèse de Simmias d'après qui l'âme serait au corps ce que l'harmonie est à la lyre, en remarquant que l'âme préexiste par rapport au corps, alors que l'harmonie présuppose l'existence de la lyre. «Tandis que accord et désaccord... sont deux contraires, l'âme n'a pas de contraire. D'autre part l'accord fait la santé, la force et la beauté; mais ce sont là des modalités de l'âme, non ce qui en constitue la nature» (L. ROBIN, *Notice* à l'éd. du Phédon, p. XLIII, n.1; P. § 234, n.1).

(*) This lecture was delivered on December 25, 1976.

MOUTSOPOULOS, *La musique dans l'œuvre de Platon*; Paris, P.U.F., 1959.

Cependant, dans la *République*, œuvre à peu près contemporaine, la structure ternaire de l'âme est expressément comparée à la structure d'une harmonie, c'est-à-dire d'une échelle musicale dont les trois sons ou termes principaux, la *nète*, la *mèse* et *l'hypate*, correspondant, dans la musique grecque aux bornes extérieures, c'est-à-dire aigue et grave ainsi qu' à la borne commune moyenne, réunissant les deux tétracordes de cette échelle, représenteraient respectivement les trois parties de l'âme en question. (*Rep.*, IV, 443d; P - § 58, n. 9).

Certes, l'opposition de ces deux textes n'est qu'apparente, car le Socrate du *phédon* ne nie pas la *structuce* harmonique de l'âme du point de vue psychologique, mais surtout du point de vue métaphysique. Seulement, les notions et la terminologie mises en cause demeurent encore confuses. Il faudra attendre les derniers dialogues du philosophe, notamment le *Timée* et les*Lois*, pour les voir précisées, au moyen du principe de *mouvement musical.*

S'il fallait situer le mouvement par rapport à l'ensemble de la dernière forme de la philosophie platonicienne, on le rattacherait volontiers à la catégorie de *mélange des contraires*, qui a tellement hanté le philosophe dans ses dialogues dits métaphysiques.

Le problème de l'opposition de l'être et du non-être, esquissé déjà par le *Théetète est* résolu dans le *Sophiste* par la reconnaissance d'une certaine manière d'être au non-être (E. MOUTSOPOULOS, Du fondement négatif de l'Art dans le «Sophiste» de Platon, *Athena* (en grec), Athènes, t. 62, 1959).

Celui de l'opposition de l'illimté et de la limite, posé dans le *Philèbe*, est résolu par l'introduction de la notion de *mesure harmoricue.*

Enfin, celui de l'opposition du même et de l'Autre, posé dans le *Timé*, est résolu d'une manière plus complète, bien que plus compliquée, par un double mélange, du Même et l'Autre avec leur propre mélange, ce qui implique une transformation complète de leurs essences respectives originelles. Ce melange définitif constitue l'essence de l'*Ame du Monde.*

Par la suite, cette substance est décomposée en termes ou parties définies par des rapports précis, et impliquant des intervalles entre lesquels le Démiurge introduit des médiétés, c'est-à-dire de nouveaux termes intermédiaires supplémentaires.

L'analogie de ces opérations démiurgiques avec celles consistant en l'analyse de certaines dennées musicales est frappante.

Le rapprochomont des notions d'âme et d'harmoine, déjà effectué dans la *République*, se renouvelle ici sur un plan cosmique et, partant absolu.

On se rend parfaitement compte de la hantise que la notion de mélange, médiété, d'intermédiaire, exerce sur la pensée de Platon.

Dans le *Philèbe* (51 c) encore, la solution des contraires repésentés par l'aigu et le grave est ramenée à l'unisson. L'opposition des termes extrêmes de l'échelle musicale est résolue dans l'un des termes moyens de celle-ci.

Dane le *Timée* cependant, cette solution facile est en partie rejetée. Elle est simplement maintenue à propos de l'introduction des médiétés supplémentaires entre les termes fondamentaux contitufs de la stucture de l'Ame du Monde.

Le rapprochement de l'aigu et du grave s'effectue ici non pas par leur suppression réciproque, mais par leur affirmation. Il se passe, ici encore, sur le plan humain, à propes des sons, ce qui a été constaté, sur le plan cosmique, à propos du mélange du Même et de l'Autre : l'aigu et le grave se *fondent* dans leur propre consonance et dans leur propre harmonie.

Mais ce rapprochement, cette fusion, ne sont possibles comme on le verra, qu'en tant que résultant du mouvement des sons qui est lui-même un *intermédiaire* entre la *matérialité de la nature du son* et la *spiritualité ses effets sur l'âme.*

On le voit bien, Platon escamotte le problème délicat de l'intermédiaire entre le repos et le mouvement en considérant un type de mouvement à part, celui de mouvement musical, et en érigeant celui-ci en principe de continuité entre la matière et l'esprit.

Comment s'acomplit, toutefois, cette liaison mouvementée dn corporel avec l'intelligible ?

Un texte du *Timée* nous donne la définition du son . «D'une manière générale, admettons que le son est le choc, transmis, à travers les oreilles, par l'intermédire de l'air, du cerveau et du sang, jusqu à l'âme». *(Timée,* 67a ; P- 15, n.5). Suit une définition de l'audition qui serait «le mouvement que ce choc détermine, lequel commence à la tête et se termine dans la région du foie» *(ibid).* Ainsi donc naissent les impressions auditives.

Le centexte dans lequel sont insérées ces définitions nous autorise à affirmer que les bruits-en tant qu'opposés aux sons musicaux-sont en principe

de cause. Les sons dont il est ici question, sont ceux-là mêmes qui, dans le *Philèbe* (5lc), sont décrits comme «uniformes et clairs».

Platon semble ignorer ou, du moins, négliger la propagation par liberation. Il est certain que son époque considérait les phénomènes physiques autrement que les physiciens d'aujourd'hui. Et le *Timée* prétend précisément être une somme des connaissances de l'époque, et plus particulièremet de celles qui étaient l'aboutissement des recherecbes de l'Académie.

La théorie platonicienne distingue deux phases du mouvement sonore, l une *externe* qui concerne son passage à travers l'air, l'autre interne qui commence dés que le son a franchi l'oreille. L'on remarquera que nulle mention n'est faite de mouvement vibratoire, et que le rôle du tympan est négligé, l'oreille servant de simple orifice.

Si son mouvement est rapide, lisons-nous dans le *Timée,* le son est aigu; s'il est plus lent le son est plus grave; s'il est uniforme, le son est homogène et doux...; s'il est grand, le son est fort...; *(Tim* 67a; p. 21, n.5).

Il faudrait voir dans cette définition complexe une illustration nouvelle ins, qu'*un son est de hauteur proportionnelle à sa vitesse.*

Le son, ayant atteint le cerveau, lui transmet son propre mouvement qui passe, par la suite, dans les vaisseaux sanguins, traverse le corps de la tête au coeur, et, de la, *région du foie,* dernière étape du trajet. Il s'agirait frémissement causé par un grincement.

Il faudreit voir dans cette définition complexe une illustration nouvelle de la théorie déjà énoncée dans le *Phèdre,* sur l'âme dont les trois parties siègent à des endroits déterminés.

Or, justement, d'après la théorie du *Timée,* le mouvement du son atteint successivement les sièges respectifs des trois parties de l'âme, par l'intermédaire du sang, le rôle des nerfs en tant que conducteurs de stimuli étant ignoré.

Ainsi l'âme tout entière en est imprègnée.

Un autre texte du **Timée** qui se rattache manifestement au précédent fait de la nature de la concordance des sons harmonieux, que nous percevons rapides ou lents, aigus ou graves, et tantôt faux, en raison du manque d'accord avec les mouvements qu'ils provoquent en nous, tantôt justes en raison de leur accord avec eux» (**Tim**., 80ab; p-522, n.3).

Ici surgit une difficulté. Platon considère que la concordance des sons dépend de la ressemblance ou de la compatibilité de leurs propres mouvements avec les mouvements qu'ils provoquent en nous. Or, nous l'avons vu, il affirme par ailleurs que leur hauteure est proportionnelle à leur vitesse de propagation. Si donc, d'après la nouvelle définition de la perception des accords, les sons ne sont concordants que dans le cas où leurs vitesses sont égales, il en résulterait qu'il n'y aurait point de sons consonants en dehors des sons de même hauteur. On serait ainsi remené à la solution facile du mélange des contraires musicaux entrevue par le **Philèbe** (51c). Or ce n'est pas ce que Platon entend, lui qui était au courant des recherches, de l'école d'Archytas lequel avait établi des rapports numériques entre des sons de hauteurs différentes et discerné certains accords fondamentaux.

Timée nous évite toute fausse interprétation de sa théorie en y introduisant implicitement la notion de **ralentissement** du mouvement des sons dès que ceux - ci ont atteint le corps, **ralentissement progressifs** et, Platon ne fournissant aucun détail sur l'éventualité contraire, reglier. Il serait dû à la réaction du corps au passage du son, ou encore à la nature même des sons concordants, ainsi, que l'on serait enclin de le penser d'après l'explication finaliste que le **Timée** donne.

Platon abandonne ici ses considérations physiologiques, pour se placer sur un plan intelligible, en admettant que la rapidité des mouvements internes n'influence nullement la hauteur des sons que ceux-ci représentent.

Il s'agirait donc d'une reconstitution de l'harmonie préétablie entre deux sons. Seuls sont concordants les sons entre lesquels une telle harmonie préexiste.

Les vitesses initiales des sons dépendent de leurs hauteurs respectives; mais une fois le corps atteint leur ralentissement n'entraîne aucune diminution des hauteurs.

Sur un plan tout différent, cette conception qui met en cause la simultanéité de perception de deux sons, rappelle la conception moderne de la **localisation en direction,** qui est biauriculaire, et dont la cause principale est la différence, d'ailleurs infime, du temps d'accès de l'onde sonore, aux deux oreilles.

Considérons un instrument musical, une cithare, par exemple, situé à une certaine distance de l'oreille humaine et émettant, si l'on fait vibrer simultanément deux de ses cordes, deux sons entre lesquels il existe un

rapport constant numériquement exprimé par 1 : 2 -et ce serait le cas de l'octave -ou encore par 2 : 3 -et ce serait le cas de la quinte.

Dans le cas le plus simple, celui ds l'octave, l'un des deux sons serait de hauteur et de vitesse doubles par rapport à l'autre.; par conséquent le parcours dans l'air s'effectuant à vitesse constante pour chacun d'eux il parviendrait à l'oreille en un temps deux fois moindre que l'autre,

Or dès le seuil de l'oreille, la vitesse est modifiée selon une loi de décroissance d'autant plus rapide que ne l'était la vitesse initiale. Ainsi, au bout d'un certain temps, les vitesses des deux sons sont devenues égales et, dès lors, ceux-ci, s'étant fondus, se propagent pendant le reste de leur trajet à **la même vitesse** qui s'annure fin de parcours, c'est à-dire dans la région du foie. Par contre, la hauteur des sons n'est pas altérée à leur passage de l'air dans le corps, mais demeure rigouresement constante.

Ces mouvements s'étteignent, puis meurent, car ils sont mortels, leur harmonie n'étant qu' une ombre à travers le corps humain laisse des traces. ceux qui perçoivent les harmonies, les uns sont des insensés qui éprouvent une **sensation agréable,** une simple réjouissance, car ils ne peuvent se l'expliquer du fait de leur ignorance; les autres, des sages qui éprouvent une **jouissance raisonnée,** car ils contemplent, à travers ces harmonies fugitives, l'harmonie éternelle participant ainsi à la connaissance du bien suprême. Une distinction **qualitative** des plaisirs auditifs vient se superposer ainsi à la distinction **essentielle** établie par le **Philèbe** entre plaisîrs mélangées et plaisirs esthétiques purs (**Phil.,** 51d; p. 172, n.9) entraînés par la nature même et la pureté de certains sons.

Dans le **Banquet,** Eryximaque conteste la valeur de l'assertion d'Héraclite selon qui, l'unité, «en s'opposant à elle-même, se compose, de même que l'harmonie de l'arc et de lyre» (HERACL., frgt 51, Diels; p. 26, n.9), et constate qu'il est absurde d'affirmer qu'il existe harmonie entre choses qui difiérent; ceci n'est plausible que si l'on admet préalablement que l'aigu et le grave, opposes à l'origine, se sont ulterieurement mis d'accord; «l'harmonie. L'harmonie, en effet, est une consonance, et la consonanc, une sorte d'accord. Or l'accord en tant que les opposés sont opposition, ne peut en résulter; et .. avec ce que est opposé et qui ne s'accorde pas on ne peut faire une harmonie» **Banquet,** 187a., trad. L. ROBIN; p. 126, n.10).

Ce texte préfigure déjà la solution mathématique qui sera donnée au problème métaphysique du mélange dans le **Timée** et le **Philèbe.** Celui-ci reconnaît la diversité illmitée des sons grands et aigus, lents et rapides que «l'adjoncton de la limite harmonise en y introdusant le nombre». L'on assiste ainsi, chez Platon, au passage d'une théorie physique, puis physio-

logique, à une théorie psychologique comportant des perspectives métaphysiques.

Ce que l'on peut retenir de cette théorie «psychologique» platoncienne, c'est que le principe général de **mouvement musical** est appliqué à l'explication du phénomène de l'audition et se trouve même étendu jusqu'au concept de l'âme.. Le mouvement dynamique des sons se transmet au corps et, à travers celui-ci, à l'âme. Le plaisir résultant de ce movement de l'âme caractérise la contemplation du beau éternel dans les réalités sonores.

L'exposé du **Timée** sur le mécanisme par lequel la musique s'introduit dans l'âme trouve une illustration tardive chez Aristide Quintilien. «Quoi donc d'étonnant, écrit celui-ci, si l'âge, recevant un corps de nature semblables aux cordes et aux souffles qui font mouvoir les instruque et bein rythmée d'un souffle par son propre soufle, et si, quand une que et blon rythmée d'un souffle par son propre soufle, et si, quand une corde pincée rend un son, toutes les fois que cela est supposé arriver à une cithare, elle résonne et se tend en accord avec elle ?» (ARIST, QUINT., XVIII, p. 107 Meib.; que 192, n.3).

On peut déduire de ce qui précède que le principe de mouvement musical s'applique aussi bien au mouvement des sons que nous avons qualifié d'externe, qu'au mouvement des parties de l'âme, qualifié d'interne.

Le **Timée** insiste sur l'harmonie cette fois transposée sur le plan de l'équilibre entre les diverses parties du corps, entre le corps et l'âme, enfin entre les facultés mêmes de cette dernière. Alors que la psychologie de la **République** était purement «théorique», celle du **Timée** est à la fois normale et pathologique. En tant que telle, elle se prolonge dans les **Lois**. Le mouvement musical est dès alors considéré comme un principe thérapeutique.

Très influencé par les théories de la médecine hippocratique, Platon insiste sur l'importance du maintien et, le cas échéant, du rétablissement de rapports d'équilibre et d'harmonie entre le diverses parties de l'entité humaine.

L'accent est désormais porté sur le plan médical du maintien de l'équilibre de l'âme et du corps. Dans ce cadre, il est affirmé dans le **Timée** qu'il ne faut jamais «meurir .... l'âme sans le corps ni le corps sans l'âme, afin que, se défendant l'une contre l'autre, ces deux parties gardent leur équilibre et leur santé» (**Tim.**, 88 b—c; p. 67, n.5).

Une âme dans un corps faible manifeste sa vitalité en provoquant la fièvre et d'autres anomalies (**Tim.**, 87e—88a); de même, un corps plus fort et plus cultivé que l'âme, lui cause des troubles, dont le plus grave est

l'ignorance. (Tim., 88b). Les facteurs des troubles causés par l'hypertrophie de l'âme ou du corps sont des **mouvements** s'affrentant de sorte que ceux «de la partie la plus forte l'emportent» **Tim.**, 88b).

Le problème de l'équilibre entre l'âme et le corps, ainsi qu'entre leurs propres parties, se trouve, dès lors, transposé au niveau de l'équilibre de force entre ces mouvements. Dans le cas de l'hypertrophie du corps, on aura recours aux mouvements musicaux (**Tim.**, 89a); dans le cas inverse, on fera appel, en particulier, à des procédés de motion corporelle.

Des mouvements internes interviennent afin de compenser par leur régularité l'action néfaste des movements qui proviennent de l'extérieur. Il s'agit d'immuniser le corps et l'âme contre l'action de ces derniers, par une méthode éducative qui ne permet jamais au corps de demeurer au repos, en lui imprimant constamment quelque agitation (**Tim.**, 88d; P — §69, n. 1).

Cette méthode d'accoutumance par l'exercice rythmique n'est applicable que sous deux conditions : en effet, il est en **Premier lieu,** éxigé que l'équilibre des fonctions de l'âme, et la conscience de l'état défectueux du corps ainsi que de la nécessité de son immunisation graduelle, soient parfaits, ce qui suppose que les enfants n'ayant pas atteint cette connaissance de soi, et les «possédés» l'ayant perdue, ni les uns ni les autres ne peuvent pratiquer à eux-mêmes la méthodc; il est exigé **ensuite,** que l'âme soit en mesure de forcer le corps à des exercices désagréables, mais utiles parce que salutaires.

Si ces conditions ne sont pas remplies, c'est-à-dire si les mouvements requis ne peuvent provenir d'une âme elle-même défaillante, on a recours, selon le cas, soit à la méthode d'immunisation préventive, soit à celle de guérison purificative, toutes deux faisant intervenir des mouvements rectificateurs externes.

L'on remarquera, ici encore, la distinction de deux sortes de mouvements, externes et internes. Mais, alors que les mouvements externes se dirigent du milieu exterieur vers l'âme, ceux considérés comme internes se dirigent de l'âme vers la périphérie corporelle.

Le mouvement musical n'est point opposé au repos, mais principalement au mouvement **désordonné** qui régne partout où l'harmonie n'est pas encore établie, même chez les inanimés, ce qui est expressément formulé par la description de la genèse de l'univers dans le **Timée.** Cette genèse ne s'effectue pas par la déchéance de l'intelligible. Le démiurge demeure transcendant par rapport à la matière. S'il intervient, c'est, simplement, comme le

Nous anaxagoréen, pour y mettre de l'ordre. «Toute cette masse visible, il l'a prise, **dépourvue de tout repos (!), changeant sans mesure et sans ordre,** car il avait estimé que l'ordre vaut infiniment mieux que le dêsordre» (**Tim.**, 30a; P-§251, n.5). Ainsi, du devenir, la matière passe, à travers l'harmonie du mouvement musical, à l'être, en devenant Ame du Monde. Il en est autant des êtres animés, ainsi qu'en témoigne un texte du livre II des **Lois** (653d — 654a) dont la ressemblance avec le passage du **Timée** que je viens de mentionner est plus étonnante. Voici ce texte des **Lois** : «Tous les jeunes êtres, ou à peu près, sont incapables de tenir en repos leur corps et leur voix; ils cherchent sans cesse à remuer et à parler, les uns en sautant et en bondissant,....les autres, en émettant tous les sons de la voix possibles. Or, les autres animaux n'ont pas le sens de l'ordre et du désordre dans leurs movements, de ce qu'on appelle rythme et harmonie; mais à nous, les Dieux....nous ont donné un sons du rythme et de l'harmonie, accompagné de plaisir....en nous entrelacant les uns aux autres par des chants et des danses....». L'analogie des deux textes est frappante. La musique, don divin, accomplit ainsi chez l'homme le même travail que la volonté du démiurge cosmique, ce qui explique parfaitement la présence de ce que l'on peut appeler le «moment musical», dans la cosmogenie du Timée. Remarquons à ce propos, que le rôle de l'analogie des idées et des thèmes de la pensée de Platon dans son oeuvre n'a été que trés peu souligné jusqu'ici. Science et imagination artistique concourent à la construction de l'Univers dont l'ame portera en germe tout le contenu. Cette âme cosmique est reflétée dans l'âme humaine qui, dès lors, devient le cadre de changements profonds de sa propre nature. Elle aussi se manifeste à l'origine par des mouvements désordonnés qui, se prolongent jusqu' à l'aspect corporel de l'être humain, mais, par l'intervention de la musique, c'est-à-dire de changements profonds de sa propre nature. Elle aussi so manifecte à du mouvement ordonné, il est possible que l'ordre et l'harmonie se rétablissent en elle, puis en l'être humain dans son ensemble. Le passage ne se fait plus ici du devenir à l'être, mais ainsi que nous l'avons vu, de l'ignorance à la connaissance et à la sagesse, ou encore sur un plan quelque peu différent, d'un état maladif à un état de santé, lui-même impliquant un passage d'un déséquilibre à un équilibre, passage auquel Platon se référe, d'ailleurs, expressément.

La qualification des divers états d'équilibre ou de déséquilibre entre les parties du corps est une illusion à la doctrine empédocléenne. «On ne.. permettra pas» à des élements disproportionnés «de s'opposer en ennemis ni d'enfanter pour le corps les guerres et les maladies. mais on les rapprochera» de façon à faire suivre l'équilibre, d'un calme — non d'un repos — intérieur «et on donnera ainsi au corps la santé» **Tim.**, 88e; P — §70, n. 7). C'est par l'observation naturelle que l'on devra commencer. Or. le balan-

cement rythmé qui nous est imprimé par un bateau» (**Tim.**, 89a), est pour Platon le type même du mouvement régulier.

C'est à des mouvements analogues que le philosophe aura recours quand il s'agira de passer de la thérapeutique du corps à celle de l'âme. Un texte important des **Lois** établit que l'âme défaillante éprouve une sorte de frayeur manifestée par des battements de coeur, et par des mouvements corporels déréglés (**Lois**, 790c (VII)).

Ici encore, l'observation naturelle fournit à Platon un certain nombre d'éléments constitutifs de sa théorie sur les rapports de l'âme avec le corps. Une vaste partie de ces conceptions est alimentée par des considérations sur les nouveau nés. «Du corps aussi bien que de l'âme des tout petits enfants, il est avantageux..que..toute la nuit comme tout le jour il y ait en plus du nourrissage une sorte de branle....comme s'ils ne cessaient de naviguer sur la mer» (**Lois**, VII, 790c; P § 70, n.4).. La ressemblance de ce passage des **Lois**, avec celui du **Timée** que je viens de mentionner est ici encore frappante.

Les mères qui veulent endormir les enfants ayant le sommeil difficile procèdent selon un principe qui, à première réflexion, parait peu fondé, sinon sur une expérience séculaire : si les enfants s'agitent et pleurent, elles leur procurent non pas la tranquillité, mais le mouvement qui, après l'agitation, apporte l'apaisemont. Il se produit une sorte de conflit de mouvements où ceux du type du balancement rythmé, s'imposent par leur régularité. «Quand..à de tels états psychiques on imprime de l'extérleur unc secousse, continue Platon, le movement ainsi imprimé de l'extérieur autres : une fois qu'il l'a surmonté, produisant l'apparition d'une paisible bonace à la suite des pénibles battements dont sursautait le coeur de chacun, il fait obtenir aux enfants le sommeil, résultat bienvenu....» (**Lois**, VII, 790e—791a; trad. L. ROBIN).

Une berceuse accompagne généralement les mouvements des bras; nous l'avons déja vu, les sons cxercent, eux aussi, une influence bienfaisante sur l'âme, par l'intermédiaire du corps.

La musique proprement dite et la danse opèrent chez les enfants ou, dans des cas particuliers, ches les adultes, à la manière d'**incantations** : «les mères, affirme l'Athénien des **Lois**, ench ntent leurs bébés comme on enchanterait des bacchants frénétiques» **Lois**, VII, 790e - trad. A. Dies-; P - § 73, n. 10).

Quant aux procédés de guérison des états corybantiques, ils se ramènont au procédé général de guérison de la peur, car, leurs causes mises à

part, ces états sont identiques aux précédents en tant que traduisant une irrégularité de l'âme manifestée en premier lieu par des mouvements violents du coeur, puis par des mouvements violents du corps, qui aboutissent à une véritable «frénésie». Platon insiste sur le fait que, cette frénésie étant un état morbide, des guérisseuses spécialisées avaient comme tâche de rétablir l'ordre dérangé dans l'âme des patients, en procédant par incantations consistant à la fois en chants et en danses (aussi **Lois**, VII, 791e; Diès; P - §73, n. 7).

Ce procédé était déjà éprouvé du temps de Platon : «On sait....l'importance que les pythagoriciens ont accordé......à l'enseignement de la musique en tant qu' éducatrice de l'âme et du corps» (Lasserre, p. 47; P-§73 n.1), ainsi qu'aux cures musicales. On connaît la légende d'après laquelle le devin Mélampous aurait apaisé la furie organique «en la surexcitant par des danses sauvages pour mieux la maîtriser ensuite,» méthode qui rappelle, des techniques analogues pratiquées actuellement en Afrique, et qui tendent à substituer à l'état de possession latent et diffus....une possession explicitée.

Dans le **Banquet** (215. d), le **Criton (54d), l'Ion (536e), Platon** fait déjà mention de ces pratiques des rites corybantiques. Dans le même cadre de traitement homéopathique de l'âme s'inscrit aussi selon toute vraisemblance, la catharsis aristotélicienne. Platon semble pourtant préconiser plutôt un traitement thérapeutique par allopathie, qui semble remonter au musicien pythagoricien Damon dont l'influence sur notre philosophe n'a pas été jusqu'ici suffisamment soulignée.

Platon considère donc que la musique exerce une action calmante. On ne saurait ignorer l'importance de ces considérations sur lesquelles est fondée toute la théorie platonicienne de l'éducation par la musique et la danse. L'âme purifiée par l'éducation musicale, se manifeste désormais par des mouvements réguliers. On peut ainsi concevoir une serie de mouvements réfléchis.

Le milieu extérieur auquel s'adressent les mouvements de l'âme éduquée, milieu symbolisé par la cité, est encouragé à poursuivre son effort d'immunisation des corps et de purification des âmus, de sorte qu'il s'instruit un circuit de mouvements musicaux réguliers exprimant la soumission de l'arythmie au rythme, de l'irrégularité à la loi, désordre à la soumission de la déficience à l'équilibre.

Il apparaît ainsi et ceci sera notre conclusion, qu'à l'intérieur du cadre délimité par l'étude du psychiqul dans les derniors dialogues platoniciens,

en particulier dans le **Philebe**, les **Lois** et, surtout le **Timée**, le principe de movemlnt musical occupe sous ses diverses formes, une place inportante et joue un rôle capital dans la résolution des antinomies existant entre le l'éducatif, l'individuel et le collectif. Il est lui-même une médiété polyvalente, et partant une mise à part qui assure la continuité entre l'essence et les principales manifestations sensibles de l'humain.

THE VIENNA CIRCLE*

ALFRED AYER

It is characteristic of Viennese positivism, which played such an important role in the second quarter of this century that almost no subsequent work of any philosophical interest has been unaffected by it,that its origin at the turn of the century is chiefly to be ascribed to one who was professionally a phy sicist rather than a philosopher. This man was Ernst Mach, who lived from 1838 to 1916, and became a privatdozent at the University of Vienna in 1863, the year he also published his first book, a compendiumof **Physics for Doctors,** having previously published half -a-dozen articles, most of which alr eady exemplified his life-long interest in the interconnections of physics with psychology. Four years later, before he was thirty, he was appointed to a professorship at the Charles University in Pragne, where he continued teaching experimental physics for the ensuing twenty-eight years. It was during that period that he published his two most important books entitled, in their English translations, **The Science of Mechanics** and **Contributions to the Analysis of Sensations.** They both appeared fairly late in his career, **The Science of Mechanics,** originally in 1883 and the **Analysis of Sensations** in 1886, but they had been preceded by seven other books principally on optics, acoustics and scientific methodology, and by more than a hundred published articles.

In 1895, the University of Vienna decided to institute a third Chair in philosophy and Ernst Mach accepted an invitation to become its first occupant, on condition that he was also allowed to give lectures on psychology. He himself chose the title of Professor of the History and Theory of the Inductive Sciences, a title which was changed by his successor, the famous physicist- Ludwig Boltzmann to Professor of Theoretical physics and Natural philoophy, Boltzmann did not sympathize with Mach's philosophy of physics, and this change of title enabled him to claim that he had no predecessor,so that he was able to avoid the courtesy of paying any tribute to Mach in his inaugural lecture This was in 19o2 Mach had suffered a stroke in 1901 which obliged him to retire from the Chair, but did not prevent him from writing four more books, of which the

* This lecture was delivered on December, 20 1980.

most important is one entitled, in English, **Knowledge and Error,** which appeared in 1905. It has recently been re-issued as a volume in the splendid Vienna Circle collection which is being published by H.D. Reidel, Company with headquarters in Holland and some sort of footing in Boston. The books are not cheap, especially for superannuated English professors, but fortunately as a member of the editorial advisory board (whose advice I may say has never yet been asked for) I get them free.

Philosophically, Mach's views were very similar to those of the American pragmatist William James – the novelist Henry James's elder brother and in my opinion the better writer of the two – well, perhaps not the better writer but the more fun to read. The difference between their styles is just the opposite of what you might expect. Paradoxically, it is Henry, who writes with the careful qualifications and minute attention to detail that one might expect of a philosopher, and William, who carries the reader away with his humour and zest and the vividness of his imagery. William James, on holiday from Harvard, met Mach in Prague in 1882 and they took greatly to one another. Among other things, James explained Hegel to Mach. Goodness knows what he said, since he had a very strong distaste for Hegel's philosophy, but he may have enabled Mach to understand how that sort of monolithic idealism could be emotionally attractive to tender minds.

The philosophy which James and Mach share was one that later came to be known as Neutral Monism. This was after it had been taken up by Bertrand Russell who held it from 1914 when he published **Our Knowledge of the External World** until at least 1921 when he published **The Analysis of Mind.** Later he moved away from it in the direction of scientific realism. **The Analysis of Matter** which came out in 1927 marks the turning point. though the old view never wholly lost its attraction for him, and he occasionally rather startlingly reverts to it. Its basic tenet is that neither mind nor matter is part of what Russell called the ultimate furnitnre of the world. Both are constructions out of neutral stuff – the raw material of experience – most often simply called experiences by James, sensations by Mach and sensibilia by Russell. The first two terms are not happily chosen because they suggest a subordination of matter to mind, which was not intended. James called his theory 'Radical Empiricism, and Mach acknowledged the affinity of his views to the classical British empiricists of the seventeenth and eighteenth centuries, Locke, Berkeley, Hume – and especially Hume. Indeed, if one treats Hume as an analyst rather than a sceptic, an approach for which there is virtually

no historical warrant, but one that requires surprisingly little tampering with the text, one can make a neutral monist out of him.

The dominant idea is that the difference between mind and matter is not a difference in substance, a distinction between two different sorts of stuff, but a difference in the relations of the basic elements. One and the same experiential item, in virtue of its relations to other elements, is both a member of a class of such items which we call a physical object and a member of the series which constitutes some person's mental biography (the person himself being nothing but a fusion of two classes of these different sorts). The way it was supposed to work was vividly illustrated by William James. His example is that of a typical case of sense-perception, his reader's current perception of James's book and of the room in which he is sitting. Philosophers will be most likely to tell him that the physical objects, which he takes himself to be perceiving, are not directly presented to him; the immediate data of perception are subjective impressions to which it is inferred that external objects correspond But the trouble with such theories, as James says, is 'that they violate the reader's sense of life, which knows no intervening mental image but seems to see the room and the book immediately just as they physically exist'. And what is more, it is the reader here who is right and the philosophers who are wrong. The philosophers have gone wrong because they have not been able to see how it was possible 'that what is evidently one reality should be in two places at once, both in outer space and in a person's mind'. This difficulty is removed once it is seen that the object's being in two different places is no more than a matter of its belonging to two different groups, or as James prefers to put it, two different processes. For my own pleasure, and I hope yours, I am going to quote James's account of these processes in detail. My excuse is that it represents Mach's view but is expressed more racily than anything I have been able to find in Mach.

One of these processes, James explains, – and now I start quoting: 'is the reader's personal biography, the other is the history of the house of which the room is part. The presentation, the experience, the **that** in short, (for until we have decided **what** it is it must be a mere **that**) is the last term of a train of sensations, emotions, decisions, movements, classifications, etc. ending in the present, and the first term of a series of similar 'inner' operations, extending into the future, on the reader's part. On the other hand, the very same **that** is the **terminus ad quem** of a lot of previous physical operations, carpeting, papering, furnishing, warming, etc. and the **terminus a quo** of a lot of future ones, in which it will be concerned when undergoing the

destiny of a physical room. The physical and the mental operations form curiously incompatible groups. As a room, the experience has occupied that spot and had that environment for thirty years. (This is careless even by James's standards; what he means is that one of the groups to which the experience belongs is strung out over that period – he makes the same mistake again and I must ask you to make the necessary adjustments). As your field of consciousness it may never have existed until now. As a room, attention will go on to discover endless new details in it. As your mental state merely, few new ones will emerge under attention's eye. As a room, it will take an earthquake, or a gang of men, and in any case a certain amount of time, to destroy it. As your subjective state, the closing of your eyes, or any instantaneous play of your fancy will suffice. In the real world, fire will consume it. In your mind, you can let fire play over it without effect. As an outer object you may occupy it for any length of time rent-free. If, in short, you follow it in the mental direction, taking it along with events of personal biography solely, all sorts of things are true of it which are false, and false of it which are true if you treat it as a real thing experienced, follow it in the physical direction, and relate it to associates in the outer world.

You see now why I said that it is William and not Henry James who ought to have been the novelist. All the same, it is an attractive theory and worth working out in detail. Unfortunately, like most attractive theories in philosophy, when you do try to work it out in detail, it turns out to be false. Neither Mach nor James nor Russell nor those who have worked on the theory since, including myself, have ever succeeded in specifying the relations which would have to hold between the sensory elements for them to constitute on the one hand any sort of physical world and on the other a set of mental biographies. Nor, I am afraid, is it merely a matter of our incompetence. There are good reasons with which I will not trouble you (you may already be wondering when you are going to get back to Vienna) – there are good reasons for concluding that such a programme cannot be carried through. I do however still believe – I am one of the very few philosophers nowadays who does – that one can defend a rather less ambitious theory along something the same lines.

But how, you may ask, did a first-rate physicist like Mach– and he was a first-rate physicist–had Einstein's word for it forty-six years ago, if you will allow me both to drop names and to appeal to authority ; anyhow, in the case of physics how did a first-rate physicist come to adopt a theory of this type? How did he deal with atoms and electrons and quanta ? He died too soon to be troubled

with black holes and quarks but their arrival hasn't made the problem essen tially different? The answer is that he took a pragmatic or operationalist view of physical theories. They were imaginative constructions.,the point of which consisted in their providing you with a means of ordering your observable data and so enabling you to make successful inferences from one experimental situation to another. There was no need to suppose that the entities which figured in them really existed, any more than in applying mathematics, you need to postulate the reality of a Platonic world of numbers. This approach to physics has its difficulties, though Mach is not the only physicist to have adopted it - the fashion nowadays sets towards realism-but I think that the pragmatist view is still defensible.

Five years after Mach's death his Chair of the History and Philosophy of the Inductive Sciences was revived and Moritz Schlick was invited to occupy it. Schlick, who was born in 1882, was not an Austrian but a German and he too began as a physicist. His doctoral dissertation, which he completed at the University of Berlin in 1906, under the supervision of Max Planck, was about the reflection of light in a non–homogeneous medium. Though he retained an interest in physics-he wrote a paper on the Philosophical Significance of the principle of Relativity as early as 1915 and two years later a small book on Space and Time in Contemporary physics which drew praise from Einstein, he early decided to pursue an academic career in philosophy rather than in physics and held professorships first at Rostock and then at kiel before coming to Vienna. His philosophical interests were wide, embracing ethics and aesthetics as well as the philosophy of science and the theory of knowledge Indeed the first book that he published in 1908 (one of the few of his works that has never been translated) was entitled **Lebensweisheit Versuch einer Gluckseligkeitslehre** and was, as the title indicates, concerned with the pursuit of happiness. But the book which made him famous and was probably responsible for his appointment to the Viennese Chair was his **Allgemeine Erkenntnislehre (General Theory of knowledge**) which he published in 1918, bringing out a second and considerably revised edition in 1925. Strangely, it was not until 1974 it was translated into English.

By the time he published the second edition of this book Schlick had been converted to a view of science which was substantially the same as Mach's,and he had also come to think, again agreeing with Mach, that the basic statements of observation were statements about sense-data. In the original edition, how-

ever, he had adopted a more realistic standpoint. He insisted that every scientific statement or theory must be capable of being verified , in th sense that it had to have consequences which were capable of correspondng to observable facts, but the observable facts could have physical objects for their constituents. He agreed with Mach in rejecting psycho- physical dualism, arguing that talking in mental or physical terms was just adopting one or othher way of describing the same phenomena, but he tended to treat the phenomena as physical, in some degree anticipating the current fashion of identifying mental occurrencies with processes in the central nervous system. This was another view which he was later to revise in favour of the Machian form of monism. Perhaps the most remarkable feature of Schlick's book was that he anticipated Wittgenstein, of whom he had not then heard,though he was later to come very much under Wittgenstein's influence, in rejecting Immanuel Kant's view that there could be such things as synthetic **a priori** truths, and holding that all true **a priori** propositions, such as those of logic and pure mathematics, were analytic-that is to say, true only in virtue of the meaning of the signs which were used to express them, and consequently devoid of any factual content.

Since Schlick held regular discussions with philosophical and some of his scientific colleagues almost from the moment of his arrival in Vienna, it is difficult to assign a precise date to the institution of what came to be called the Vienna Circle-**Der Wiener Kreis**-over which Schlick presided for the remainder of his life, but I suppose as good a date as any would be the year 1926 when Rudolf Carnap, one of the three leaders of the Circle (the third being Otto Neu rath of whom I shall be speaking presently) came to Vienna.

A younger man than Schlick, he was born in 1891, Carnap was also a German and also worked on a doctoral dissertation on experimental physics, though he never completed it owing to the outbreak of the first world war in which he served as an officer in the German army. He obtained his doctorate at Jena in 1921 with a new dissertation on the topic of Space-subtitled a contribution to the philosophy of Science. Like Schlick he had been struck by the philosophical importance of Einstein's Theory of Relativity and with the exception of one pamphlet concerning the part played by the concept of simplicity in physics, and another on the different levels of the construction of physical concepts, the passage from the qualitative to the quantitative and from the concrete to the abstract, the half-dozen articles and pamphlets which he published before he came to Vienna were all devoted to the topics of Space, Time and Causality. His view of physics was already less realistic than Schlick's then was, and closer to that of Mach. Later we shall see that their posit-

ions were reversed. Carnap had been an undergraduate at Jena and had been one of the very few students there to attend Gottlob Frege's courses on mathe. matical logic. Frege who lived from 1848 to 1925 and published his most important work from the 1870 s to the 1890 s, is now almost universally acknowledged to have been the greatest logician since Aristotle but he was almost totally unknown in Germany in his lifetime, and unappreciated even in his own university, where he never achieved the rank of full professor. Throughout one of his courses, given in 1913, there were only three persons in the audience of which Carnap was one. Frege's work was indeed known to Russell who discovered a contradiction in Frege's system-the possibility of constructing in it the famous class paradox,– the class of classes which are not members of themselves being a member of itself,if it is not, and not being a member of itself if it is, and communicated it to Frege just before the publication of the second volume of Frege's magnum opus on the Foundations (Grundgesetze) of Arithmetic, a blow from which Frege never fully recovered. Through Frege, Carnap learned of Russell's and Whitehead's **Principia Mathematica,** and went on to study Russell's works on the theory of knowledge, written during the period of Russell's neutral monism, and was very greatly influenced by them. Carnap had read the **Principia** when he was at Jena but did not possess a copy, and at the time of post-war German inflation could not afford to buy one. Nor could he borrow a copy from the library of the University of Freiburg, to which he had moved from Jena, since there was not any copy there and never had been. He therefore applied to Russell who did not send him a copy but wrote Carnap a 35-page letter, setting out all the most important definitions on which the proofs in the **Principia** were founded. This enabled Carnap to compile his **Abriss der Logistik** (Outline of Mathematic Logic of which he wrote the first draft in 1924 though it was not published till 1929 It made him the first German philosopher, so far as I know, to take official notice of the expansion of logic, at least in its bearings on the foundations of mathematics, some fifty years after Frege had initiated it.

Upon his arrival in Vienna, Carnap set himself to complete the first of his Major works (The logical construction of the world) which appeared in 1928. It also had to wait ever forty years for an English translation. An exceedingly ambitious work, displaying, as all Carnap's work did, enormous industry and exceedingly high technical accomplishment, it adopted the standpoint of what Carnap called methodological solipsis B. The wordmethodological, was put in to disinfect the solipsism, but it may be doubted whether it was sufficient

for the purpose. Anyhow, Carnap, following Mach, James and Russell after his own fashion, took as his starting point the series of elements each constituting the whole of a person's current experience at a given moment, and attempted to show how the entire battery of concepts needed to describe the world could be constructed stage by stage, the application of Russell's logic, on the basis of the single empirical relation of Ahnlichkeitserrinerung (remembered similarity). The higher levels of the construction, the development of physical objects and the constitution, out of a sub-class of them, of other minds are sketched only in outline, and Carnap's ingenuity is mainly spent in showing how qualities like colours can be defined on the basis of the primitive relation in a purely structural extensional fashion. He did not succeed in this, as was shown some thirty years later by Nelson Goodman, in his remarkable book **The Structure of Appearance.**

Carnap did not remain long in Vienna; he and another prominent member of the Circle, the physicist philipp Frank, both left in 1931 to take up professorships at the Charles University in Prague; but he continued through his writings to exercise a predominant influence over the movement. In 1930, the Circle had taken over a journal called **Annalen der Philosophie,** renamed it Erkenntnis, and made it the chief outlet for the expression of their views, and Carnap continued to edit in collaboration with Hans Reichenbach, another philosopher of physics, with a special interest in the theory of probability, who presided over a smaller group in Berlin. Carnap was also one of the three authors of the manifesto which the Circle published in 1929 under the title **Wissenschaftliche weltauffassung- Der Wiener Kreis** (roughly translatable as Viewing the World Scientifically- The Vienna Circle). The other two authors were Hans Hahn, a professor of mathematics at Vienna University who died in 1934, and Otto Neurath, perhaps the strongest personality of them all, the most humorous and physically the largest; he used to sign his letters with a drawing of an elephant,

Neurath was not attached to the University of Vienna, but the director of a Social and Economic Museum which he himself had founded in 1924. He had been born in Vienna in 1882 and educated at the Universities ot Vienna in 1882 and educated at the Universities of Vienna and Berlin. He began by studying mathematics in Vienna, went on to linguistics, then to wal, then to economics, and then to sociology. The thesis with which he

obtained his doctorate in Berlin in 1906 was on the subject of the economic thought of the ancient world. The eighty articles which he published before the first world war were mainly concerned with economics but some of them were political. He was greatly interested in the Balkans, especially Serbia and to a lesser extent Bulgaria He published a short piece for example on the Bulgarian railway-system) and half a dozen of them were in the field of logic amd mathematics. In the whole of his career he published only one substantial book, his **Empirische Soziologie** (Empirical Sociology) which came out in 1931, and for all its considerable merits appeared in an English translation only in 1974, but over two hundred and seventy articles. After doing his military service in the Army Service Corps, in which he was to serve again mainly in Galicia during the war, he taught political economy at the New Vienna Academy of Commerce. He was not yet a a socialist, though well schooled in the writing of Karl Marx and other socialist authors, but joined the social Democratic party in 1918, partly as the result of his war experiences. He had ended the war as Director of the Museum for War Economy in Leipzig, being seconded from the Ministry of war in Vienna, and was appointed to a lectureship at Heidelberg in Max Weber's department of Sociology He gave this up in order to serve the Socialist Government which had been set up in Bavaria with its headquarters in Munich, and was soon put in charge of its central planning. When this government was replaced by the so-called Spartacist government, consisting of Communists, left-wing Socialists and Anarchists working for once in some sort of cohesion, Neurath stayed on. This government was soon overthrown by the reactionary Freikorps known like their unsuccessful counterparts in Russia as the white forces (white in this context is opposed not to 'black' but to 'red') Having narrowly escaped assassination by count von Zeppelin, who subsequently made some sort of amends by marrying an American who translated Carnap's **Logische Syntax der sprache** into English, Neurath was arrested and sentenced to eighteen months imprisonment in a fortress. But the Austrian government intervened and the sentence was commuted to expulsion from Germany, and a seven-year ban on his returning there. He remained a socialist and drew closer to Marxism, without, however, becoming a Communist. Nearly all the members of the Circle held left-wing views but the others did not bring them into their philosophy. Neurath alone saw the Circle as being in part a political movement. I shall have more later on to say about the subsequent course of his extraordinary career.

In the appendix to the Manifesto the members of the Circle are listed

as fourteen in number. Besides those already mentioned (Schlick, Carnap, Neurath, Frank and Hahn) they consisted of the philosophers Viktor Kraft Gustav Bergmann, Herbert Feigl, Marcel Natkin, Theodor Radakovic and Friedrich Waismann, and the mathematicians Karl Menger Kurt Godel and Olga Hahn-Neurath, Hans Hahn's sister and Neurath's second wife. Bergmann and Feigl soon left to take up appointments in the United States and were replaced by Bela von Juhos and Edgar Zilsel, already mentioned in the Manifesto as a sympathizer. The Circle was in close contact with Reichenbach's tiny group in Berlin, of which the most prominent members were Richard von Mises, like Reichenbach himself an ardent defender of the frequency theory of probability, the logician Kurt Grelling and the young Carl Hempel, who was later to have an outstanding career in the United States, and with the more important group of Polish logicians and philosophers, of which the leading representatives were Lucasievicz, Lesvnievsky, Chwistek, Kotarbinski, Ajdukiewicz and Tarski. It was also on the look out for what one might call likely prospects in other countries. It was, for example, my very good fortune that Schlick met my Oxford tutor Gilbert Ryle at an international congress held in England in 1930, with the result that two years later when I had taken my B. A. degree at Oxford and was allowed a few months leave of absence before starting work as a lecturer, Ryle advised me to go to Vienna. He gave me a letter of introduction to Schlick which I summoned up the courage to present, calling on Schlick in his handsome apartment in the Prinz Eugenstrasse. He spoke good English (he had an American wife) and made on me above all an impression of urbanity-like an American senator in a pre-war film. He graciously invited me not only to frequent the University but, what was much more important, to attend the meetings of the Circle. It was there that I first met Quine. I was just twenty-two and Quine a few yeas older–he had already taken his doctorate at Harvard. I remember his giving us a lecture-some sort of preliminary to his New foundation in Logic. My own German was then too rudimentary for me to do more than vaguely follow what was going on, but helped by reading all of their publications that I could lay my hands on.

Apart from **Erkenntnis,** the most important source for what was going on in those early years, the Circle put out a series of monographs with the collective title of Einheitswissenschaft (Unified Science-this was a pet idea of Neurath's, not only that philosophy was to be annexed to science but that there was no difference in method between the natural and the social sciences

and a series of books, under the general editorship of Schlick and Philipp Frank, with the collective title of **Schriften zur Wissenschaftlichen Weltauffassung.** They included Neurath's **Empirische Soziologie,** a book by Schlick on Ethics, **Fragen der Ethik,** defending a form of Utilitarianism, one by Frank on **The Law of Causality** and its Limitations and Kar Popper's **Logik der Forschung** (translated into English over twenty years later as **The Logic of Scientific Discovery).** Popper, though teaching at a highschool at Vienna at the time was never admitted into the Circle (I don't know why--there may have been personal reasons) and has always exaggerated the difference between his views and theirs. There were differences, but only, in my opinion, of a minor character. I shall return to this briefly later on.

The first volume scheduled to appear in the series, continuing to be advertised as No. 1 even after the appearance of all the others, was Waismann's **Logik, Sprache, Philosophie,** title from which my own **Language, Truth Logic** was partly plagiarized. It never did appear, mainly because of the debt which it would have owed to Ludwig Wittgenstein. To explain this I shall have to say something about Wittgenstein himself, apologizing to those of of you for whom it is an old story. Born in 1889, he came from a rich Viennese family – I think they largely controlled the Austrian steel industry – and studied engineering at Berlin. He then, like Engels before him, was despatched to Manchester, where he worked on aerodynamics. This led him to take a deeper interest in mathematics and he became aware of the work of Frege and Russell on mathematical logic. As a result, he went to Cambridge in 1912 to study under Russell. There is a story of his attending a course of Russell's lectures, never saying a word but coming up to Russell at the end of the course and saying: Either I am a genius or I join the Austrian air force, which? He looked a genius, but that was not quite enough for Russell, so he asked Wittgenstein to submit him some written work. When they met again at the beginning of the following term Russell said: Don't join the air force'. After that they worked on equal terms (if anything, Russell deferring to the much younger Wittgenstein – Russell himself was born in 1872 until the war when Wittgenstein fought for the Austrians – not as it turned out for their air force but as a machine gunner. He was captured by the Italians, allegedly after the Armistice, and was held as a prisoner of war well into 1919.

Two important things happened to Wittgenstein during the war. The first was that he decided, some say as a result of reading a work of Tolstoy's,

that it was wrong for him to be so rich and gave all his money away. A story which I have heard but do not vouch for is that he did not give it to the poor, since that would corrupt them, but to his sister who had a rich husband besides being rich in her own right, so that a third fortune couldn't do her much harm.) The second more important event was the completion of the only book he published in his lifetime – the famous **Logische- Philosophische Abhandlung -** Tractatus-Logico Philosophicus in the English version (Latin in this context has to count as English), which appeared as a a lengthy article in the Annalen in 1921, and was published in England in 1922 with the German text and English translation by C.K.Ogden (part-author with C.I. Richards of the **Meaning of Meaning** and the inventor of Basic English)on facing pages, with an introduction by Bertrand Russell.

In view of the very great influence of the **Tractatus,** almost immediately on the Vienna Circle and eventually on the younger generation of British philosophers, it is worth giving a very brief summary of its central ideas. They were that the world consists of what in the original translation were called atomic facts (**Sachverhalte** – a better rendering would have been states of affairs), which are logically independent of one another. These basic facts are mirrored by elementary propositions. To have any literal significance a sentence must express either a true or false elementary proposition or one that assigns a certain distribution of truth or falsehood to the elementary truth·possibilities, in which case it is a contradiction, or it may agree with them all, in which case it is a tautology. The true propositions of logic were tautologies and so virtually were the propositions of Mathematics, though Wittgenstein preferred to call them identites. They could be useful in inference but in themselves said nothing about the world. Anything else that failed to satisfy these conditions of meaning (and this included all transcendent discourse whether religious, moral or metaphysical) was a pseudo proposition– a piece of nonsense. This included philosophy too, which was not a body of doctrine but an activity, the activity of clarifying what could be said and preventing the expression of what couldn't. There was a mystical strain in Wittgenstein which led him to hint at the existence of things outside the reach of language. In some cases, such as the relation of language to the non-linguistic facts, what could not be said could be shown. This partly emerges in the formulation of the famous concluding sentence of the **Tractatus: Wovon man nicht sprechen kann daruber muss man schweigen'** – what we cannot speak about we must consign to silence–provoking from Neurath the characteristically robust comment: **Man muss ja schweigen aber nicht**

uber etwas – We must indeed be silent but not about anything – A point still better put by Ramsey as "What you can't say you can't say and you can't whistle it either'.

After publishing the **Tractatus** Wittgenstein became a village schoolmaster at a place called Trattenbach in the mountains four hours journey south of Vienna. The boys seemed to have liked him, thouhg he was eventually accused of beating them too hard, but the villagers didn't, nor he them. He worte to Russell that the men of Trattenbach were the wickedest in the world, a proposition which Russell found improbable. They did, however, succed in making Wittgenstein's position at the school untenable, and he returned to Vienna to become an architect. I don't know that he ever collaborated on any building except a house for his sister which is now the Bulgarian Embassy. It was in the style of Gropius. About 1925 his interest in philosophy revived and he made contact with Schlick, Carnap and Waismann. In 1929 he was persuaded to return to Cambridge as a Fellow of Trinity, succeeding G. E. Moore as a professor in 1939 and holding the Chair till ill-health forced him to resign it two or three years before his death in 1953. Throughout the thirties he continued, however, to return to Vienna almost every summer. He quarrelled with Carnap over Carnap's **Aufbau** apparently on the score of plagiarism. Carnap had acknowledged his debt to him but this was taken as an aggravation of the offence. Wittgenstein is reported to have said: I don't mind a small boy stealing my apples but I do mind his saying that I gave them to him (but continued to discuss philosophy with Schlick and Waismann, especially Waismann who was Schlick's assistant. The trouble was that Wittgenstein was changing his ideas. One can follow out the course of this change by reading the so-called Blue and Brown books-notes of his lectures dictated to his pupils and posthumously published, and find its fuller effects in Wittgenstein's posthumous **Philosophical Investigations,** which I am not going to try to summarize apart from saying that its main theme is that we fall into philosophical perplexity through misunderstanding the logic of our language, a thesis not proved but supported by a wealth of brilliant examples) and Waismann's book was designed in part to reflect these changes. Wittgenstein was not opposed to this in principle but in fact prevented its appearance by insisting year after year on further revisions. The story ends sadly. When the Nazis invaded Austria in 1938 Waismann fled with his wife and son to Cambridge and was given a position there. But there was no place in Camb-

ridge for an echo of Wittgenstein and Wittgenstein did not welcome him there. Fortunately Oxford took pity on him and made him a Reader in the philosophy of Mathematics, a post which he held till his death in 1959. He suffered private misfortunes-both his wife and his son committed suicide- and remained rather an isolated figure, but he went on working, mainly in his later years composing epigrams. His book was published posthumously and did turn out, to my mind at least, to owe too much to Wittgenstein's **Investigations.** The sad thing was that he was philosophically gifted in his own right. His book **An Introduction to Mathematical Thought** (first published in German in the thirties) and his series of articles in **Analysis** in the 1950's on Analytic-Synthetic are well worth reading.

The original position of the Vienna Circle was very much that of Wittgenstein's **Tractatus,** on the assumption that Wittgenstein's elementary propositions were observational, except that they did not adopt his pictorial theory of language. The points which they chiefly pressed were the subordination of philosophy to science – it could not compete with science because there was only the natural world which the science, with the support of observation for their theories, already wholly covered – all it could do was analyse the information which the science provided, perhaps do something more positive in the way of sharpening scientific concepts (functioning in Carnap's phrase as the logic of science), and secondly, the exclusion of metaphysics-- represented by any attempt to go beyond what Hume (in whose work almost the whole of Viennese positivism was foreshadowed) called matters of fact. This was affected by the use of their famous principle of Verifiability – the slogan expressed by both Schlick and Waismann in the form 'The meaning of a proposition consists in its method of verification'.

It did not detract historically from the power of this slogan that it concealed many difficulties. For example, how strong was the verification to be? At the beginning, Schlick insisted on conclusive verification, but this threatened to rule out scientific generalizations; unless they were construed as finite conjunctions, which was not plausible, they could not be conclusively verified. It was on this point that Popper joined issue with the Circle, advocating a principle of Falsifiability and treating it not as a criterion of meaning but as a principle of demarcation. Only propositions which were falsifiable were to be accounted scientific. This propositon had its advantages but Popper actually defined falsifiability in such a way that it did not cover abstract theories, that is theories containing nonobservational terms or

even statements of probability as he construed them. Not that in these respects his opponents were in any better case. Where he chiefly went wrong was in supposing that he had evaded Hume's problem of induction. It still needs to be explained why a hypothesis which we have tried and failed to falsify should gain credibility from passing the test.

Others, like Carnap, preferred to weaken the principle of verifiability by requiring no more than that propositions should be confirmable. Unfortunately they didn't, and we still don't, have a watertight formal theory of confirmation, with the result that the principle of verifiability never got itself satisfactorily formalized. I made a valiant attempt to bring it off in the second edition of my **Language, Truth and Logic** but Alonzo Church torpedoed me.

But worse is to come. The principle, as Schlick and Waismann stated it, fused two separate functions – that of deciding when a particular proposition was meaningful and that of deciding **what** meaning it had. The second was the more ambitious but it raised an awkward problem. Was it to be verifiability by the author or interpreter of the proposition, in which case its meaning would depend on who he happened to be and what spatio-temporal position he occupied, and you at once run into difficulties concerning propositions about the past (they had to be interpreted as propositions about the availability of present and future evidence), and propositions about other minds which had to be interpreted behaviouristically, a course which was later found to lead to an all–out behaviourism or, if not behaviourism, physicalism. By no means all philosophers object to this but it still seems to me to require one's feigning anaesthesia. The alternative was to rely on the fiction of an ideal observer, but this is not a very precise notion. With what powers is he to be credited ?

There was disagreement also about the nature of protocollsatze, the Circle's term for the basic observation-statements. Schlick and Waismann followed Mach in taking them to be sense-datum statements but Neurath who won over Carnap, insisted that they must refer to the observation of physical objects. As I now recollect it, the discussion of this point occupied many of the Circle's sessions at which I assisted. Carnap was away in Prague but Schlick and Neurath battled it out, neither convincing the other. The advantage of Neurath's position was that he avoided a lot of awkward problems. But had he the right to? Schlick faced the problems but ran into difficulties-especially over the question of solipsism. How did he arrive at the public external world of which Neurath and Carnap were making themselves a present? He eventually

hit on the ingenious solution of construing public statements as statements about structure as opposed to content. It does not matter to me what the content of your experience is like, whether, if I could **per impossibile** get into your skin I should not find that the world seemed very different, so long as I can cash your statements and your reactions to my statements in ways that make sense to me in terms of my own experience, and all that this requires is that our respective worlds have a structural correspondence. I once thought that this distinction between structure and content could not be so sharply drawn but I am now more inclined to think that there is a good deal in this idea.

Another disputed issue was that of the nature of truth. Schlick held some form of correspondence theory, but Neurath and Carnap maintained that to talk of comparing sentences with facts was metaphysical. Sentences could be compared only with other sentences. They were therefore driven to hold a coherence theory of truth. To the obvious objection that many incompatible systems of sentences could each be internally coherent, Carnap replied that the true one was that which was accepted by the scientists of our culture circle. But this, as I pointed out at the time, was a fudge. Each one of the competing systems might consistently contain the sentence that it alone was accepted by contemporary scientists. What Carnap meant was that only one of them was so accepted in **fact.** But why should it be only at this point that fact is allowed to intrude ?

This outlawing of semantics, for that was what it came to, vitiated Carna **Logical Syntax of Language** which came out in Vienna in 1934 and wa translated into English in 1937. Technically, it was a monumental feat, bsd sthe attempt to make syntax do the work of semantics failed and so did the co tr ual of philosophical propositions, where they were not metaphysical, as syntactical statements masquerading as statements of fact (this was the nub of Carnap's celebrated distinction beween the formal and material modes of speech). Whatever else they were,p hilosophical propositions were not syntactical.

Carnap's eyes were dramatically opened at a congress in Paris in 1935 when Tarski presented an abstract of his semantic theory of truth. There-after semantics became respectable and Carnap published three books on it between 1942 and 1947. The Circle had held previous congresses, two at prague and one at konigsberg (though it had no particular respect for Kant) but the Paris one was by far the most ambitious. Bertrand Russell came to it and was treated as an honoured figure, though he always held considerable

reservations about Logical positivism. I don't remember meeting him then though we became close friends in the years after the second war. I do remember meeting Karl Popper there for the first time. With the menace the of the Nazis he was shortly to leave Vienna for New Zealand from which he eventually made his way to London School of Economics. An even more vivid mem ory is that of my introducing Neurath to the noble but formidable Susan Stebbing and his disconcerting her with the remark : I have always been for the woman's By that time Neurath was living in Holland. There had been civil war in Vienna in 1934 when Dolfuss's right wing forces overthrew the municipal government and stormed the Socialist stronghold, the Kari Mar Hof. Neurath was on their list of wanted men but luckily he was in Moscow, on some business connected with his Institute, which he then set up at the Hague. Most of its work then consisted in the production of what he called Isotypes, pictorial statistics.

If Neurath's removal weakened the Circle, a mortal blow was dealt to it in 1936 by Moritz Schlick's murder. He was shot on the steps of Vienna University. It was not a political act, but the work of a demented pupil. The right wing press duly deplored it, but there was a faint suggestiotthat this was the sort of fate that radically anti-clerical professors might expect to suffer.

Neurath made a valiant attempt to keep the movement going. His main ambition was to produce an International Encyclopaedia of Unified Science, and he visited Chicago in 1936 to arrange for its publication by the University Press. An organizing committee was set up, consisting of himself, Carnap, Philipp Frank, Charles Morris who was teaching at Chicago, the Danish philosopher Jorgen Jorgensen whom the war was to turn into an ardent Marxist and Louis Rougier, pretty well the only French neo-positivist of the time, who was to become an emissary of the Vichy government. The encyclopaedia never amounted to anything more than a handful of brochures, for the most part not very distinguished with the notable exception of Ernest Nagel's **Principles of the Theory of Probability.**

The German occupation of Austria dispersed the Circle. So far as I know, only Neurath and Waismann among its members were Jewish but the radical spirit of the group, and its rational outlook, made it unacceptable to the Nazis. Vienna's loss was America's gain: Carnap holding a profefessorship first at Chicago and then in California, Frank and I think also Menger going to Harvard, Godel, perhaps the most gifted of them all, to the

Institute at Princeton. I have said nothing about Godel because his work lay wholly in the technical field of mathematical logic, and I doubt if even in his youth he wholeheartedly subscribed to the main doctrines of the Circle. As early as 1940, if Russell's evidence is to be trusted, his view of mathematics was Platonistic. The Berlin group also escaped: Reichenbach and von Mises to California, after a stay in Istanbul, and Hempel early on to Brussels, and then to the United States, eventually establishing himself at Princeton. Of the Poles, Kotarbinski and Ajdukiewicz remained in Poland and survived the war, Lucasiewicz was sheltered by his pupil Scholtz at Munster and subsequently became a professor in Dublin, and Tarski settled in California.

Even after 1938 Neurath tried to keep things going. He took over **Erkenntnis,** renamed it The Journal of Unified Science and arranged for it to be published at the Hague, but only a few numbers appeared. At final congress, which I attended, was held in Cambridge in 1938 but the only members of the Circle to come to it, besides Neurath and Waismann, were Frank and Feigl who came over from the U. S. In 1940, when the Germans invaded Holland, Neurath and his third wife escaped to England as passengers on a crowded small boat. He was interned for some months as an enemy alien, and when released re-opened his Institute. He died suddenly in December 1945, his last years having been devoted almost entirely to the production of his pictorial statistics. The other members of the Circle continued working but no longer as a group. Carnap was the most productive, his later work consisting almost entirely of an attempt to develop a system of inductive logic

Von Juhos and Kraft remained in Vienna, inconspicuously, throughout the war but the climate had changed, metaphysics was back in fashion, and so far as the University of Vienna was concerned, the Circle might never have existed. It was different elsewhere. True, with the possible exception of myself, no one any longer cares to be called a logical positivist, but the Circle has left its imprint on successive generations of English philosophers, including Ryle and Austin and their disciples, on the work of Ernest Nagel, Quine, Nelson Goodman, Hilary Putnam and other distinguished American philosophers, on von Wright and Hintikka in Finland, on groups in Sweden and the Low Countries. Its influence has percolated even to Germany and France. If one goes through the theses advanced in the early numbers of **Erkenntnis** in detail, one finds that nearly all of them are questionable and many of them false. But their spirit still triumphs. A strain of what I can best describe

a s woolly uplift was banished from philosophy – I daren't say never to return, that would be too optimistic, but where it survives or reappears, at least to face criticism of akeenness which we owe very larhely to those heroes of my **youth.**



ALIENATION AS A SOCIAL AND PHILOSOPHICAL PROBLEM*

ADAM SCHAFF

1. Alienation and its definition:

Let us begin not with any theoretical formulations, but with a description of definite social facts, which will enable us to make theoretical generalizations.

Now various people (groups of various size, and sometimes single individuals) produce various objects which serve to satisfy various human needs: tables, chairs, clothes, food, houses, TV sets, automobiles, etc. They thus produce objects for use (use values), which, however, reach the possible consumers not directly, but through market systems of various kinds. We say that they produce for the market (i.e., for anonymous consumers), on which objects for use appear as commodities. An object for use, which appears on the market as a commodity begins to live its own specific life, governed by the market laws of demand and supply. Under certain conditions this results in disturbations which may cause social repercussions on a wide scale: depressions, unemployment in those branches of production which are affected by depression, etc., etc. Material products of human labour,intended to satisfy given human needs, function as market commodities in a way which is independent of the intentions of their producers, and in some cases they are even handled by the market in a way which is in contradistinction with those intentions and which endangers the interests of the producers or just destroys them (economically at least) during depressions.

And here is another case: scientists for at least two generations (on the global scale) have striven to make use of nuclear energy. Today we know in detail the fascinating history of their striving, which were organically connected with the history and the outcome of World war II. Man has succeeded in making the exploit which is undoubtedly a milestone on his road to the understanding of the secrets of the universe. When the large numbers of scientists throughout the world set themselves that research task, they certainly had in view above all a better comprehension of the structure of matter and the conquest of new, practically unlimited, sources of energy. It was only

* This lecture was delivered on December, 21, 1980.

later, during World War II, that the group of scientists headed by Fermi and sponsored by Einstein succeeded in solving the problem in practice; when doing so they had military goals in view in order to ward off the threat of the Nazi **Wunderwaffe.** And what is the result of those endeavours of two generations of scientists throughout the world ? The secret of nuclear energy has been unveiled and mankind has thereby acquired unprecedented and unknown sources of energy. This has opened new vistas to the development of mankind, whose power can now vie with that of ancient gods. But at the same time mankind has come to face the danger of annihilation: the threat of a total destruction has become real. And this is not because anyone wants that: no-one, except madmen, wants to perish as a result of a total war, but because mankind has proved helpless when confronted with its own invention. This is a classsical example of the fact that human products can, under certain circumstances, start living their own life, not only independently of, but even against, the intentions of their makers. This is like the case of the sorcerer's disciple who knows the magical formula needed to set a certain force in operation, but does not know the formula which would enable him to master that force and use it in accordance with his will.

Let us now consider another sphere of social life, namely that of social institutions. These, too, have not been parachuted from the skies, but are human products, specific products of human thought and human labour. Obviously, in this case the history of mankind is involved, since we have to do with social products to be viewed in a historical perspective, yet this fact merely complicates the situation, but does not alter its character istic traits with which we are concerned here. We take all this into account when we come to discuss that special social institution which is the state. We are interested, above all, in two functions of that institution, the functions which, by following Engels's formulation, we shall term "the management of people" and "the management of things". In the former case we mean the repressive function of the state, the function of enforcing obedience by means of physical power, which is institutionalized within the state as the police, the courts, the army. In the latter case we mean the administrative function, which is institutionalized within the state as the bureaucratic machinery. In its both forms, as is shown by the history of state institutions, including their recent history, the apparatus of the state, while being a human product, rises above man, and often against man, and-according to the conditions prevailing in a given period and a given social formation--begins to function independently of the intentions of its makers and sometimes becomes their formidable, and even terrible opponent. Examples are provided by the history of the various

police forces (especially secret police), active in the various social formations. The most horrifying examples are provided by the history of wars, which shows how the military machine of the state becomes an independent force. And in every-day life we observe the estrangement of the administrative apparatus in the form of bureaucracy, a process which is not so terrifying, but which may prove even more annoying as it is connected with every manifestation of public life.

Finally, to add a new sphere to the picture, let us consider the sphere of ideas. Various systems of ideas, including those which we call ideologies because of their links with the public activities of those who strive for specified forms of social development, are human products, products of human labour, since mental work is a form of labour. Now what happens to these products of human thought ? The history of the various inquisitions, not only religious in nature and not only in post-revolutionary periods (such as the period of the French Revolution), shows tellingly how systems of ideas, formulated to serve specified purposes-usually to propagate the lofty ideals of humanity and fraternity-gradually become independent and institutionalized and under certain conditions begin to function contrary to the intentions of their founders, often destroying them or their continuators. Many a time in human history ideologies which propagated the love of one's neighbour turned into instruments of hatred and prosecution of man by man; many a time ideologies which advocated social equality turned into instruments used to construct mechanisms of social inequality. Note: against the intentions of their founders.

Let us now try to generalize these selected examples and to extrapolate that which is common to all of them despite the variety of the issues and social factors involved. At least the following common elements can be traced in the Cases quoted above and in many others as well:

(a) in each case we have to do with social activities of human beings who intentionally strive for the attainment of certain economic, political, scientific, ideological, etc., goals;

(b) in each case that intentional human activity, based on mental work (often in the form of scientific theories) which underlies the appropriate forms of action, finds its culmination in specified products of human labour: material objects intended to serve human needs; public institutions which organize social life; inventions and scientific theories; ideological systems, etc.; these products of human activity are objectivizations of human thought and

actions in the sense that both as material and spiritual goods-in the latter case as scientific theories, ideological systems, and the like- they reach beyond the subjective sphere of human life, the sphere of human thought, and acquire objective existence, i.e., they exist outside any human mind and regardless of whether anyone thinks about them or studies them at a given moment; they thus exist independently of any cognizing mind;

(c) in each case, these products of human social activity, which have acquired objective existence, from elements of a given, historically shaped, social system and are subject to the laws of its functioning, the laws which determine the place and the function of those products of human activity regardless of what their makers thought about them and intended them to be, i.e., regardless of their wishes and intentions;

(d) as a result of all that, in each the above mentioned cases (or ,more generally, in each analogous case of social activity of human beings) such products of human activity which have acquired objective existence can function not only regardless of the wishes and intentions of their makers (becoming autonomous in this sense), but also against their wishes and intentions, in a manner which contradicts those wishes and intentions of theirs, and endangers the interests of their makers or even more than that, in a manner which simply destroys their makers.

Now all those social phenomena which reveal the characteristics described above are cases or manifestations of **alienation.** We have thus arrived at a definition of the process in which we are interested here, not by formulating any stipulating definition, but by extrapolating those characteristics which are common to a certain class of social facts and by generalizing them adequately. Obviously, the adoption of this procedure has been made easier by the fact that we have an appropriate theory which we here merely intend to present and explain; yet, as our reasoning shows, a person who is not in possession of such a theory could arrive at the same conclusion. It is also obvious that terminological issues, especially when it comes to the term alienation, are of a secondary importance. There is no objection whatever to replacing the term alienation as the name of the class of facts with which we are concerned hereby some other term, provided that it grasps the essential characteristics of the relation which underlies the facts discussed in this paper.

When we refer to alienation, then the very term brings out the fact, so ipormtant for that relatino, that products of man's social activity under

certain circumstances can function otherwise than intended by the man or the men who made it, and that they are "estranged" in that sense. Hence our definition of alienation would be: By alienafion we mean such a relattion between a human agent and the product of his activity in which that product, having acquired a socially objective existence and being situated in a given social system, function not only autonomously (i. e., independently of the intentions of his maker), but under specified conditions, even against the wishes and intentions of his maker, and sometimes endangers his interests or his very existence.

Now the same social facts can be interpreted from another viewpoint, these two interpretations being not mutually exclusive, but complementary. The above remark refers to the problem of intentionality and spontaneity in social development. While human actions are always intentional, their results, and hence the processses unleashed by such actions, may be spontaneous, not intended by the agent (s). That element of spontaneity is linked to the relation of alienation as mentioned above: social processes become spontaneous and follow a course not intended by the agent (s) just because, under a given social system, human products function otherwise than intended by their makers, that is, to use a philosophical formulation, human products become alienated. Appropriate countermeasures intended to eliminate the effects of the process described above may be interpreted both as counteractions against alienation and counteractions against the spontaneity of social processes. This, however, does not want to say that alienation is the same as spontaneity; it merely shows that they are organically interconnected: where there is alienation, social processes tend to become Spontaneous. Alienation is the Cause and Spontaneity of Sotial Processes is the effect, but not vice versa.

We have so far interpreted alienation as an objective social relation between a human agent and the products of his activity: products of human activity become alienated when they societally function as objective beings otherwise than intended by their maker. But is not the maker himself, **qua** agent, subject to alienation, too?

He is, and in two ways at that.

First, man, as manpower, in the system of market economy becomes himself a commodity and as such is subject to the general regularities which govern the alienation of commodities. This aspect of the issue, especially as far as the alienation of human labour (both the process and the results of that labour) is concerned, has been analysed in detail in classical Marxist literature.

Secondly. which is of particular interest. the alienation of man interpreted as autoalienation-to be distinguished from the alienation of products of human activity-contributes a new, subjective, element to the problems of alienation. As mentioned above, the issue is interesting because it takes our reflections onto another level: while so far we have been concerned with the objective process of the alienation of products of human activity which function regardless of, or even against, the intentions of their makers, now, by raising the issue of autoalienation we pass to the level of subjective experiences of human beings, that is, we enter the sphere of subjective facts, even though the causes of the process are objective in nature. The issue is interesting also because the recent revival of interest in the problems of alienation (which took place after World War II) is most intimately connected with the problems of autoalienation as problems of subjective experiences, studied by French existentialists, who are responsible for that revival of interest in alienation. It has been probably due to that connection that the public, including competent sociologists who undertake empirical studies of the issue, has come to the groundless and erroneous conclusion that the problems of alienation are identical with those of autoalienation.

While we note the relative independence of these two spheres of the studies of alienation and reject the reduction of the problems of alienation to the sphere of subjective experiences of alienated human beings (and to the causes of that process). we cannot, and should not, belittle the importance of the problems of autoalienation. The latter process manifests itself now whenever we analyse present-day social life; its issues, which used to be mentioned as fairly independent processes even in the classical Marxist literature, require investigations and explanations.

In this case we cannot offer such plain examples as in the case of alienation in its objective sense. The problems are much more intricate and require, even if we have plain descriptions in view, much skill in writing. This is why we confine ourselves here to a general typology of the problems involved.

What do we mean by the term **autoalienation?** Since the issue pertains to man himself, and not to the products of his labour, the problem consists in man's alienation (estrangement) from something, namely with respect to something which is a system of reference. Two cases are singled out here from among the many possibilities offered by this interpretation.

First, and this is the issue which is the most frequently raised in the literature of the subject (including the **belles lettres),** we have to do with the estrangement of the individual from society, his feeling of being alien to

social problems, with the resulting lack of his participation, not to speak of engagement, in public life. We have here to do with a conflict of interests between the individual and society, a situation which is frequently observed in the case of delinquents, especially the juvenile ones. The process is even more strongly marked in various social trends, especially of the young people, such as the hippie movement. The situation, which in the literature of the subject is labelled with extravagant and much publicized terms such as "the lonely crowd", lost individuals", anarchism", etc., in fact reduces to a simple, though extremely important fact, a fact which strongly affects present-day societies, especially in advanced countries. That fact is that in those count ries, following industrialization and the resulting growth of large agglomerations of people, human communities there become in a sense mass communities, marked by (a) weakening or even disappearance of the traditional bonds that used to link the individual to his community (family, neighbourhood, vocational, etc. bonds), and (b) unprecedented dependence of the individual upon the social organization of which he is a small part. The new organizational forms (except for rare case of certain political, religious, etc., groups marked by extraordinary forms of inner solidarity) do not replace the old bounds of group solidarity and the resulting sense of close links with other people. This results in that unnerving feeling of loneliness, which certainly is not an invention of "the rotten bourgeoisie" and certainly is not the exclusive "privilege" of capitalist societies,even though it is in them that it has found its strongest manifestations. But that feeling of loneliness is merely an outer, though striking, manifestation of a deeper process which has been due to the same causes:a crisis of what in the language of philosophy is called" the sense of life", and which in fact is a result of a collapse of existing systems of values, a crisis of socially accepted goals of human activities. And the point is not whether there are adequate social programmes and adequate ideologies, but whether these are accepted (assimilated, or, to use a technical term, interiorized) by the human beings concerned.As can be seen,we have here to do with a complex of intertwined issues, which must not be underestimated merely because of the fact that it has bred extremist opinions and movements. The problem itself is certainly of considerable social importance and this is why it has become fashionable, attracting the attention not only of men of letters and philosophers, but social scientists as well.

Secondly, we might take as the system of reference those factors which are essential for the definition of man and of "human nature", and to interpret

autoalienation as the estrangement of a "real man," i. e., such as he is under given enpirical conditions from that "human" nature, interpreted universally and, so to say, suprahistorically. This approach is theoretically risky because of the possibilities of metaphysical speculations, since if we ádopt it,we have to make at least the following two assumptions: (a) the belief that there is a universal and suprahistorical "human nature", which is, to say the least, doubtful, if and when we go beyond the biological characteristics of human beings, and (b) that we have adequate anthropological knowledge which tells us what that "human nature" with respect to which alienation takes place, really is. This is why, even though the concept of a "true man" as the model a "real man" seems attractive, we better have to abandon this concept of autoalienation if we wish to abide by the empirical approach.

There have also been other variations of the concept of autoalienation, such as Feuerbach's concept of religious alienation. The latter is associated with the concept of the autoalienation of man who, by transferring upon the divine being certain human properties in their absolute form impoverishes himself by depriving himself of those properties. But these variations are of little significance when compared with the types of autoalienation specified above, out of which we retain only the first one since it complies with the requirements of a scientific theory.

We may thus formulate the following conclusions.

A distinction is to be made between the concept of alienation and that of autoalienation.

Alienation is the term used with reference to the relation that holds between a human agent and material or spiritual products of his activity and consists in the fact that the products of that human agent function, under specified social conditions, regardless of, and even contrary to, the intentions of that human agent. Alienation is thus a relation which occurs objectively.

Autoalienation is the term used with reference to the situation which consists in a human individual's estrangement from society (other possible types of autoalienation are disregarded here because of their underlying metaphysical assumptions). Autoalienation manifests itself in the experiences and attitudes of individuals, and hence is a subjective phenomenon.

Alienation and autoalienation are interconnected and interact one upon the other, nevertheless these two concepts must not be identified with one another.

2. The origin of the theory of alienation

So far we have behaved so as if the theory of alienation has been a product of our investigations only, and our-generalizations based on the results thus obtained. This is a convenient, and even didactically proper, way of presenting a theory, but this is not to say that the way of presenting the results of mental work is the same as the way of arriving at such results. It is self-evident that our analysis and presentation of the empirical data was based on a previously accepted theory of alienation. In this case, too, theory comes ahead of empirical studies.

The genealogy of the theory of alienation is a long and intricate one, but the present writer will not enlarge on it, except for that filiation of that theory which he himself accepts, i. e., the Marxist philosophy. It is obviuus that that philosophy, too, was not born-as far as the problems of alienation are concerned-**in vacuo.** Let us mention in this connection at least Rousseau and, above all, Hegel as the forerunners of the Marxist theory of alienation. This fact, however, does not make us offer any historical statement on the issue, which is usually done by those who identify philosophy with its history.

This is why, without showing too much interest in whether, how, and how far Marx drew on his predecessors when he was constructing his own theory of alienation we state merely that we have followed very strictly Marx's conception in all that which has been said above.

Let us begin first with the distinction between alienation and autoalienation.

According to Marx, alienation is an objective relation which consists in the estrangement of products of human activity, as a result of which these products come to dominate their makers. Because of the fundamental significance of this formulation, which dissociates the Marxian concept of alienation from the existentialist one, we shall resort to some quotations in order to validate our claims.

In Marx's **Economic and Philosophical Manuscripts** of 1844, in the section on"Alienated Labor" we find the following passages:

"/.../ the worker is related to the **product of his labour** as to an **alien** object./.../

"The **alienation** of the worker in his product means not only that his labor becomes an object, assumes an **external** existence, but that it exists

independently, **outside himself,** and alien to him, and that it stands opposed to him as an autonomous power. The life which he has given to the object sets itself against him as an alien and hostile force.

In that early work of his, which is however of extreme significance for the comprehension of the later development of his ideas, Marx still refers to the estrangement of a **worker,** even though all what he says refers to the alienation of his products. In **The German Ideology,** whose significance for the Marxist theory is not denied even by those who would like to see an essential breakthrough between the young Marx and Marx in his mature age, the problem is formulated quite clearly. It is true that the term **alienation,** which had also been used by young Hegelians who are criticized by Marx in that work of his, has for him derogatory undertones (which he indicates by placing that term in quotation marks), yet the definition of the process does not leave the smallest doubts. Marx starts from an analysis of the consequences of the division of labour for the spontanseous formation of society and says:

"/.../ as long therefore as activity is not voluntarily, but naturally, divided, man's own deed becomes an alien power opposed to him, which enslaves him instead of being controlled by him./.../

"This crystallization of social activity, this consolidation of what we ourselves produce into an objective power above us, growing out of our control, thwarting our expectations, bringing to naught our calculations, is one of the chief factors in historical developmen: up till now./.../

"This estrangement (to use a term which will be comprehensible to the philosophers), can, of course only be abolished given two **practical** premises."

While interpreting alienation as a specified relation which a **product** of human activity bears to man Marx at the same time emphasises the distinct nature and the relative conceptual independence of autoalienation as the alienation of man himself **qua** producer.

Let us go back to the section of the **Mansucripts** refered to above. When continuing his comments on alienation Marx says:

"So far have considered the alienation of the worker only from one aspect; namely, **his relationship with the products of his labor.** ...... However, alienation appears not only in the result, but also in the **process** of **production,** within **productive activity** itself. How could the worker

stand in an alien relationship to the product of his activity if he did not alienate himself in the act of production itself? /.../.

"What constitutes the alienation of labour?First, that the work is **external** to the worker, that it is not part of his nature, and that, consequently, he does not fulfill himself in his work but denies himself, has a feeling of misery rather than well being, does not develop freely his mental and physical energies but is physically exhausted and mentally debased. The worker therefore feels himself at home only during his leisure time, whereas at work he feels homeless. /.../

"We arrive at the result that man (the worker) feels himself to be freely active only in his animal functions /.../ while in his human functions he is reduced to an animal." (3)

Marx not only introduces here (indirectly) the term **autoalienation** ("alienate himself"), but also clearly interprets that issue in the light of the subjective feelings and experiences of a human being (a worker); he understands perfectly well that in the case of autoalination we have to do with an estrangement of a man **from something,** which shows that he assumes a system of reference. It is true that Marx takes here "the essence of man ("human nature") as that system of reference, which we have tried to avoid, but this is not a decisive point in any way. What is of decisive significance here is that he distinguishes between autoalienation and alienation and holds that the autoalienation of a human being always is his alienation **from something,** which manifests itself in the sphere of subjective feelings and experiences of human beings.

It would not be possible to engage in this place in detail the Marxological studies of the problem of alienation. The above quotations from Marx's writings are merely to confirm the validity of the fundamental statements made by the present writer and ascribed by him to Marx. The further text will be less formal, without references to quotations in support of the writer's statements. This proeedure is justified by the nature of this paper, but it makes it necessary to consider the personality of the present writer and his interpretation of the doctrine which he discusses.

And here is a tentative reconstruction of the Marxist theory of alienation (though it must be noted that every reconstruction is a kind of construction).

All productive activity, whether its results are material or mental, results in objectivization, which wants to say that the products of that activity

exist objectively, i.e., outside the minds of all cognizant subjects and independently of them. Objectivization is thus a necessary **fact** in man's individual and societal life.

A product of human activity is an objectivization in two senses: (a) in the sense of its objective existence (as explained above), and (b) in the sense of the fact that human thought, which underlies all conscious human activity, takes on an objectivized form. Yet even though a deliberate intention which sets specified goals always underlies all productive activity, the product does not always function in accordance with that deliberate intention and in accordance with the goals indicated by that intention. Since every individual lives and acts **in** society, a given product, whether material or mental, enters the existing network of social relations and functions in accordance with the laws determined by the latter, regardless of the intentions of its maker. This is why in advanced societies the products of human activity become autonomous with respect to the intentions of their makers and function indepndently of, and under specified conditions contray to, their intentions. This applies to **all** products of human activity, and not only to marketable commodities, even though Marx concerned mainly, if not exclusively, with the alienation of commodities and of the human labour that produces them. Nothing prevents us from formulating Marx's analyses in a more general manner, as he himself used to engage in such broader analyses in fields other than the narrowly conceived sphere of commodities.

It follows clearly from the above that while objectivization necessarily accompanies all human activity, it turns into alienation under certain conditions only, so that alienation is a contingency, and not a necessity, of societal life. This yields two practical conclusions: (a) that alienation can be overcome, and even prevented,if we change those social conditions in which **given** objectivization turns into, or rather degenerates into, alienation; (b) that alienation is, from a societal point of view, a **permanent** danger, since any objectivization can degenerate into alienation, under specified conditions,which vary according to the sphere of societal life and according to the category of products of human activity. These are important conclusions for social engineering in the overcoming and/or preventing alienation in societal life. We shall revert to these conclusions in the last section of this paper.

One aspect more deserves attention: the problem of alienation is organically connected with that of spontaneity in development, which was pointed out by Marx himself. This is, after all, self-evident. If alienation consists in

the fact that products of human activity function regardless of, and sometimes even contrary to, the intentions of their makers, then it is obvious that as a result societies develop not along the lines marked by deliberate intentions of human beings. but spontaneously, and hence in a manner that differs from those intentions. These close connections between alienation and spontaneity must be borne in mind when we pass to theoretical reflections on social engineering measures intended to prevent those processes which are detrimental to social development.

We have so far considered the two basic concepts in the Marxist theory of alienation: that of objectivization and that of alienation. In this connection we have to mention-even though the problem deserves a profound analysis-two other concepts, which also are closely connected with that theory, namely those of reification and commodity fetishism.

In the case of both last-mentioned concepts the point is that under specified conditions relations between human being take on the external form of relations between things(commodities and are veiled by those reified relations, which distorts the real nature of the mechanism of societal relations. Reification and commodity fetishism are thus closely interconnected: in both cases we have to do with consequences of the alienation of human labour, with the proviso that reification is theoretically the broader concept of the two, since it applies not only to marketable commodities, as in the case of commodity fetishism, but to all forms of human relation.

Linked with alienation as they are, neither reification nor commodity fetishism is conceptually identical with the former, nor can any of them replace the concept of alienation, as has been suggested by certain authors. this is so because alienation applies to all products of human activity, and not to things (material objects) alone, and because the relation between alienation the one hand, and reification and commodity fetishism, on the other,is not symmetrical: alienation breeds reification and commodity fetishism, but not vice versa. Lukacs, who at one time (in his **Geschichte und Klassenbewusstsein**) raised reification to the rank of the highest principle that was to replace the concept of alienation, at the close of his life in the introduction to the 1967 edition of that work) admitted that he had been wrong.

To conclude information on the Marxist theory of alienation a brief reference will be made to autoalienation.

As follows from the quotation above, Marx as early as in his **Manusc-**

cripts made a clear distinction between alienation and autoalienation. In his text, autoalienation is a derivative of alienation as a result of the latter in the sphere of subjective feelings and experiences of human beings. It does not follow therefore in the least that autoalienation, even if interpreted in its narrow sense of alienation from "the essence of man", from " human nature", is to be underestimated. It is true that Marx did not refer to alienation in the sense of man's estrangement from society, but at that time he did not have necessary data at his disposal (because of the stage and character of the development of social relationships at that time). Today nothing prevents us to cover those issues with our analyses; on the contrary, we are even obliged to do so if we are to apply the Marxian method in a new social situation.

Autoalienation is a derivative of alienation also in the sense which we accept here. In a world of alienated human products which reify human relations in a world that evades deliberate control by society and at the same time weakens, or even destroys, the traditional links between the individual and society, human relations face dangerous complications. This is why the problem of autoalienation, derivative as it is, is a real problem which requires adequate measures intended to overcome the processes which accompany autoalienation, or to prevent their emergence and growth.

3. **The origin of the resistance to the theory of alienation**

The theory of alienation has lately become fashionable. At the same time it has met with objections and resistance.

Protests against an inevitable simplification of that theory, with its resulting vulgarization for the sake of making it fashionable are easily understandable and may be left outside our discussion of the issue.

The same applies to the opposition on the part of the conservatives who rise against this theory which, by unveiling the real causes of social evils, works for a change in the present state of things. The theory of alienation as formulated above is aimed mainly at the class-based system of the private properrty of the means of production, since it is private property which is mainly blamed for the adverse consequences of alineation. In this case, too, we may say that theoretical objections raised by the conservatives are self-explanatory and may be left outside the sphere of our considerations.

It is otherwise when it comes to objections and protests raised by certain circles which officially profess the Marxist theory. This fact, which in same cases becomes a social problem, is neither trivial nor understandable at the

first glance. This is why we focus our attention on this fact, which is of considerable practical and theoretical importance.

Some people, who come out to defend the "orthodox" Marxist theory of alienation is alien to the Marxist theory; that interest in it is "revisionist" in nature and proves that Marxist revisionists have succumbed to existentialism and personalism, fashionable in bourgeois circles; that if the theory of alienation is to be found in Marx's works then this applies only to his youth, when he had not yet overcome the influence of bourgeois ideology, whereas in his mature works he firmly dissociated himself from that theory, and that accordingly in those later works we do find neither the term **alienation** nor the problems to which that term refers. Now all these opinions have nothing to do with "orthodoxy"and, moreover, are notoriously false. Before we proceed to analyse the origins of the birth of such opinions the present writer will comment briefly on the main points of these opinions.

First, it is not true that those Marxists who are concerned with the probems of alienation within the broader framework of the Marxist philosophy of man have drawn on the existentialists by following the "fashion". On the contrary, it was French existentialism, which after world war II popularized the problems of alienation,which drew on Marxism, what has been admitted by such authors as Sartre. Historically, priority goes to Marxism, which only ignorant people can deny.

Secondly, the problems of alienation are not peripheral in the Marxist theory and are not due to Marx's "lapses of the young age", but are fundamental in it and are connected with the basic issue of Marxian socialism, namely the striving to overcome spontaneity in favour of an intentional and planned development of societai life as a necessary condition of man's - many sided development.

This is why all other problems in the Marxist theory, whether economic, political, social, or organizational, are by their very nature historically conditioned and transitory, whereas **this** problem-the striving for planned societal development and the elimination of spontaneity-remains valid in **every** social formation. As we have seen above, the theory of alienation is most intimately connected with the issue of spontaneous development of societies, is as it were its other aspect, its interpretation from another point of view: spontaneous development takes place in those cases only in which products of human activity function at variance with the intentions of their makers, i.e., in other words, become alienated.

Thirdly, the statement on the existence of "two Marxes", between whom a strongly marked caesura can be observed (Althusser's notorious **coupure**), is simply false. That statement if often made, for their respective interpretative goals, both by those who do not like the mature Marx, since by accepting only his works written in the early period they can "deliver" Marx from Marxism and communism, and by those who, in the name of supposed "orthodoxy", reject Marx's early writings and thus try to dissociate all anthropological issues from the Marxist theory. This paper is not the place in which we can go into the details of that fascinating controversy and to prove the somewhat trivial truth that the various stages in the mental development of the great thinker form, for all the differences between them, a single whole, and that only a complex treatment of his opinions enables us to understand them fully. It is only by interpreting Marx's early opinions in the light of his later results that we can notice and understand those ideas which were important and fertile in his early period, and, vice versa, when we view his later, mature, works from the perspective of those early ideas we can grasp their latent meanings, their intentions, and the causes that had underlied his studies of certain issues. At any rate the claim that Marx in his mature period abandoned he study of alienation and related issues as ill-conceived and un-Marxist is a result of crass ignorance. It suffices to read Marx's **Grundrisse** of 1857, which was his first version of **Capital** and certainly belong to the group of his mature works (that work is often referred to by the propounders of the theory of the said **coupure** in Marx's mental development to see that such statement is simply absurd.

We may thus freely study the problem of alienation from the standpoint of the Marxist and theory cempletely disregard the objections of "revisionism" and of drawing on "bourgeois philosophers" since in both cases the evidence is to the contrary.

But we focus our attention here neither on these objections nor on our rebuttals of them. We are interested here in the problem, what accounts for the fact that a theory which developed in connection with the focal issues of Marxism and has been linked with them from the very inception of the Marxist theory, and which is aimed at the capitalist system, has come to meet resistance on the part of the Marxists themselvers and has been rejected in the name of supposed "orthodoxy". This is an intricate issue.

Two factors have accounted above all for that negative attitude toward

the problems of alienation : lack of sufficient Knowledge of the Marxist theory and unwillingness to raise the problem of alienation under socialism.

The former is rather trivial. The point is that that generation of party activists who control the "social demand" for ideological issues.was trained in the Marxist theory at the time when the problems of alienation were practically unknown. It must be borne in mind that the works of the classical Marxist authors in that field were published during the decade that preceded World war II, and hence could be an object of exhaustive studies only after 1945. We can easily understand the incredulity of those for whom Marxism used to be associated exclusively economics,class struggle, etc., and who came to be confronted with problems of man, alienation, autoalienation, etc., problems which are new to them **qua** elements of the Marxist theory.

The simplest solution was to assume that those problems are"alien"to the Marxist theory, that they have been adopted "from the outside", etc. Obviously, those who professionally write on the Marxist theory ought to know more, but, first, in fact it is not always so, and, secondly, we should not underestimate the importance of the "social demand" which comes from the party authorities and is conditioned by various factors in social psychology.

And at this point we come to the essential issue: unwillingness to engage in the study of those problems which disturb tranquility. For if one admits the study of the problems of alienation, then it becomes embarrassing when it covers socialist conditions. Of coursr, one could assume that by definition the issue applies to the capitalist market economy only, and that accordingly with the abolition of the private property of the means of production the problem of alienation vanishes. Propounders of this claim (who refer to Marx's early writings whose Marxist validity they otherwise deny) do in fact exist, but their reasoning obviously does not stand criticism. In Marx's opinion, from his young age to the end of his days, the concept of alienation was much broader and covered such institutions as the state and such ideologies as re-religion, etc. What are we to do with those alienated entities which continue to survive under socialism? And, moreover, when the concept of alienation is interpreted broadly, as we have done it here, we cannot avoid the logical consequence of the reasoning which shows that under specified conditions **any** objectivization may change into alienation. Is it then not possible that, following changes in the social system under socialism, and under communism; new structures would intensify certain forms of alienation end even breed new ones? Let us mention, by way of example, such social facts as bureaucracy, whose growth is favoured by the concentration of decisions in the

state authorities;the functions resulting from the management of things by the state, functions whose vanishing was not even postulated in the classical Marxist theory and which will expand greatly in view of the new forms and needs of management, under communism, too, so that they may even change into traditional forms of government. Hence these few examples, which could be multiplied, show that the issue of alienation under socialism is a real one.

Hence the point is not to stubbornly deny facts in order to keep up the appearances and to behave like the bureaucrat described by Gogol who wanted to "undiscover America" in order to evade the problem he was faced with. Such a policy yields no results, whether in the times of Gogol's hero or today. Real issues must be treated as real: when we have found out what their nature is we must try to solve them or to prevent their emergence in public life. That is the task of social engineering.,

4. The value of the theory of alienation for social engineering

The value and the importance of the theory of alienation consists not in the description of the untoward effects of the functioning of human products in a way which is at variance with the intentions of the makers, but in explaining why they function so, and hence in showing the measures that can eliminate such untoward effects. These indications which tell ue how to overcome the said untoward effects or how to prevent them in advance account for the significance of the theory of alienation for social engineering measures.

What are these indications? We have to find out under what condition (under what structure of the socio-political system) a given objectivization changes into alienation, and then we have either to change the existing conditions (the structure of the system) or to resort to such preventive measures that render the emergence of such conditions impossible. It must also be borne in mind that the present techniques of system analysis and simulation by models enables us easily to find out the regularities in question. The real difficulty is the social resistance to those changes in the structure of the system which are necessary for the overcoming of alienation or for its prevention, resistance on the part of those who are privileged by the existing state of things. The problem is a well-known one, and is typical not only of the class system based on private property. Yet, theoretically at least, in a mod-planning society it is now possible to instal an "analyser of dangers of alien ation" that would faultlessly indicate the paths of overcoming existing evils and, to some extent, to warn of new imminent cases of alienation,.

One point is to be stressed with special force: the problem always is to overcome a **given** case of alienation or a **given** form of alienation, and not alienation in general. Alienation "in general" cannot be overcome, since such alienation exists only in the sphere of ideas as an abstract concept, but cannot be encountered in real life. Only definite forms of those social relations which are termed alienation exist in the strict sense of that term. But the fact that a **given** form or case of alienation has been overcome does not prevent other forms from emerging. Is it then worth while striving to overcome a given form or case of alienation? What are the benefits of it if new forms may emerge? The benefit is analogous to treating a person who suffers from infl-uenza, althoug it is known that he may develop later another disease. A successful treatment of a **given** illness is good for the patient, even though we realize that he is not immune to other ailments. Moreover, a relapse is merely by **possible,** and not necessary and may be prevented by adequate measures.

The theory of alienation, by revealing to us the causes and origins of the social evil called alienation helps us considerably both to fight that evil and to prevent it. It would be unreasonable not to arail ourselves of that possi-bility only because we cannot eliminate that evil absolutely, but merely can put an end to its manifestations in concrete cases. And it is simply blamable to renounce that possibility because of one's own particular interest and to place group interest above that of society as a whole. It must be borne in mind that personal or group interests often-and not only under the capitalist system-veil facts and help people to fail to notice those things which they find inconvenient; that veil often takes on the form of a myth of some kind of "orthodoxy".

NOTES

(1) Karl Marx, **Economic and Philosophical Manuscripts,**) in: Erich Fromm, **Marx's Concept of Man,** Frederick Ungar Publishing Co., New York 1961, pp. 95-6

(2) Karl Marx & Friedrich Engels, **The German Ideology,** Parts I & III, International Publishers, New York 1963, pp. 22-4

c) 3) Karl Marx, **Eeonomic and Philosophical Manuscripts, ed. it.,** pp. 98-9

THE PHILOSOPHICAL RICHNESS OF TECHNOLOGY*

MARIO BUNGE

Headline, 20th July, 1967 : VIKING I LANDS ON MARS. Certainly a triumph of space technology. But philosophically significant? Doubtful, but then we should not look for philosophy in material objects other than human brains. If we look for philosophy at the right spots in the technological process we are bound to find some, for there is philosophy in or behind every piece of human knowledge and in or behind every step of rational action.

We shall find philosophy, for instance, in the policy making that ended up in the decision to build and send off Viking I as well as in the technological research that went into the implementation of that decision-and I am using the term 'philosophy' in its technical acceptation not in the popular one. Indeed one of the assumptions in planning the Viking I Venture was that there might be life on Mars after all. And this conjecture presupposes the philosophical hypothesis that biosystems, far from transcending matter and being the exclusive property of the Chosen Planet, are material systems existing wherever certain physical conditions prevail-a hypothesis in the ontology of the living. Another assumption- and this one belongs to epistemology-is that the design and manufacture of Viking I would need assorted and multiple scraps of knowledge: mathematical, physical, chemical, biological, and managerial-not however astrological, parapsychological, or psychoanalytic. Such philosophical presuppositions are so obvious that we may miss them, but there they are, in the background of the Viking I Mission.

This suggests that technological policy making and design do have philosophical components. However, one might concede this point while at the same time doubting whether technology poses any original and interesting philosophical problems. This is in fact the challenge.

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* This lecture was delivered on December, 20, 1983.

I take up the gauntlet. The best way of doing so will be to exhibit a good many unsolved problems in the philosophy of technology. This will be done in the sequel, but let me hasten to throw in a few as an appetizer. What kind of knowledge is technological knowledge and in what ways if any does it differ from both artisanal know-how and scientific knowledge? What kind of thing is a technological project and how, if at all, does it differ from both an ordinary-life plan and a scientific project? How does technological action differ from either everyday action or scientific activity? And how do evaluations and moral norms intervene in technological policy making, research, and action? There are, I submit, many more problems in the philosophy of technology worth the attention of even eminent philosophers, but the above sample should suffice to motivate taking a look at an emerging branch of philosophy that spans the entire philosophical spectrum from semantics through epistemology and ontology to value theory and eithcs.

1. Defining Technology

The very first philosophical problem technology confronts us with is that of characterizing it, the more so since there is no consensus as to what it is. Indeed there is a bewildering variety of ways of understanding the word technology'. The man in the street may not draw a distinction between technology and its products. The English-Speaking scholar may not distinguish between craftsmanship and technology: Thus the prehistorian may speak of the techno logy-not the technique-of stone polishing. In other languages a clear distinction is drawn between technology proper and technique, the former being defined as technique making use of scientific knowedge.

one more item on this lexicographic matter : most dictionaries tend to equate modern technology with engineering. If we accept this equality we shall not know where to place bioengineering, educational technology, and other disciplines that may not be involved in production. In general we would not know what to do with the new branches of technology that are born now and then. To avoid such embarrassment we should adopt a definition capable of embracing every future branch of technology. This is achieved if technology is characterized by its means and goals. The following definition will do for our purposes:

DEFINITON. A body of knowledge is a technology if and only if

(i) it is compatible with science and controllable by the scientific method, and

(ii) it can be employed to control, transform or create things or processes, natural or social, to some practical end deemed to be valuable.

Note that

(a)it is not necessary to be human in order to have a technology ;

(b)all of the traditional technologies-i.e. physical and biological engineering-have a nonempty intersection with science in addition to adopting the scientific method, on the other hand some of the new technologies, such as operations research and information science, share with science only the method;

(c)technology and whatever science or mathematics it presupposes are taken at the same point in time; thus we would not regard alchemical engineering as a branch of contemporary technology;

(d)the definition involves the notion of scientific method, once crystal clear and now again problematic; we shall describe it briefly in Sce. 4.

our definition of "technology" is, so to speak, intensional. Let us proceed to find out what the extension of the concept is.

2. The Technology Spectrum

our definition of "technology" makes room for all the practice-oriented disciplines as long as they employ the scientific method. In fact it suggests the following four-fold partition of the set of present day technologies.

Material ➤

- ➤ **Physical:** civil,, mechanical, electrical, nuclear and space engineering.
- ➤ **Chemical:** indsutrial chemistry, chemical engineering
- ➤ **Biochemical:** pharmacology. medicine, bioengineering.

Social ➤

- ➤ **Psychological:** psychiatry, pedagogy
- ➤ **Psychosociological:** industrial, commercial, and war psychologies.
- ➤ **Sociological:** applied sociology and politology, city planning, law.
- ➤ **Economic:** management science, operations research, human engineering.
- ➤ **Warfare:** military science.

C onceptual	**Information sciences**
General	**Systems theories:** automata theory, information, linear systems theory, control theory, optimization theory, etc.

This list is not exhaustive but can be completed: it is intended only to illustrate our definition of "technology". The list includes two genera with a single species each, namely the typically contemporary branch constituted by the various information (or computer sciences, and the collection of odds and ends I have called 'general technology' because the theories in it can be used almost everywhere regardless of the kind of system. We shall see in Sec. 8 that general technology constitutes the greatest contribution of technology to ontology or metaphysics.

Before facing any further problems in the philosophy of technology let us conduct one more preliminary investigation, this time into the conceptual relations between technology and its near ancestors and neighbors.

3. Near Ancestors and Neighbors

No branch of technology is isolated and none has emerged out of nothing. Therefore none can be adequately understood but in its relations to its near neighbors and ancestors. Every branch of technology presupposes not only ordinary knowledge and some artisanal skills but sometimes also some scientific knowledge and always also some mathematics. Technology is then rooted to other modes of knowing. And it is not a final product either: it shades into technical practice the **praxis** of the general practitioner, the teacher, the engineering consultant, the manager, the financial expert, or the military expert. Nor is everything pure in and around technology: not to speak of the artistic, ideological and philosophical components, occasionally one finds traces of pseudoscience and pseudotechnology-e.g. in some system science and some futurology. Table 1 shows some of the nearest neig hbors-in time or in goals-of technology. To complete the picture add mathematics, the crafts, the arts, and the humanities. See also Fig. 2 in Sec.13.

So much for a geography of technology. We are now in a position to locate the areas of maximal conceptual density in the technological process : there we must cast our net if we want to catch philosophical fish. To this end we must first sketch the technological process.

4. The Conceptual kernel of Technology

The philosophical components of technology are usually overlooked

because people rarely look where they should, namely at technological **research** and at technological **policy making** rather than at the practice of or at its end products. Fig. I shows the place of the areas of maximal conceptual density.

In any high grade technological process, such as one taking place in an oil refinery, a telephone network, a modern hospital, or an army, managers as well as technological investigators-but not so much white collar workers and technicians-employ a number of sophisticated conceptual tools, such as organic chemistry, electromagnetic theory, queuing theory, or decision theory. If innovating or creative, policy makers and investigators will try out or even invent new theories or procedures, not to speak of new plans for research, development and production. In sum, technology is not alien to theory, nor is it just an application of existing scientific knowledge : it has a creative compontent, which is particularly visible in the design of technological policies and in technological research. Consider the latter for a moment.,

Methodologically, technological research is no different from scientific research. In either case a research cycle looks schematically like this: Spotting the problem-Formulating the problem in as precise a manner as possible-Trying to solve the problem with the help of the (theoretical or empirical) knowledge at hand–failing that, Inventing hypotheses or theories or methods capable of solving the problem-Getting a solution (exact or approximate) of the problem with the help of the new knowledge-Checking the solution (e.g. experimentally)-Making the required corrections in the premises or even in the very Fig. 1. Flow diagram of the technological process. The first two stages-research-are occasionally missing or completed somewhere else. The end product can be an industrial good, a rationally organized institution, a throng of healed patients, a war cemetery, or a mass of docile consumers. Hatched areas: those of maximal conceptual density, formulation of the original problem. Besides being methodologically alike, in both cases research is goal oriented-only, their respective goals are different. The goal of scientific research is truth for its own sake, that of technological research is useful truth-truth for a practical purpose.

The conceptual side of the technological process is bound to be minimized or even ignored by those who equate technology with its practice or even with its material output. (Curiously enough not only idealist philosophers but also pragmatists ignore the conceptual richness of technology. Hence neither of them can be expected to give a correct account of the philosophy inherent in technology.) On the other hand, if we distinguish the

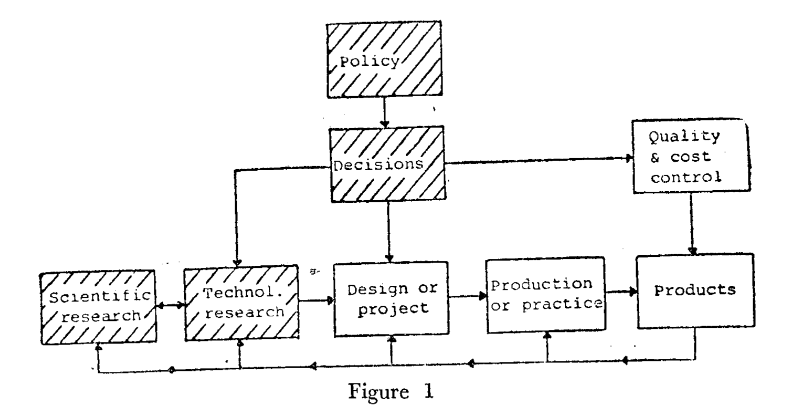


Figure 1

various stages or aspects of the technological process, and focus on technlogical research as well as on the design of technological policies, we shall be able to uncover the philosophical components of technology. A first component to be uncovered is the epistemology of technology.

5. The Epistemological Background of Technology

Technology shares with science a rich set of epistemological presuppositions. Let us recall just a few of them:

E 1 Reality is knowable if only in part.

E 2 Every piece of knowledge about the external world can be improved upon with the help of scientific research.

E3 There are various sources or modes of knowledge: perception, intuition, reason, and perhaps] others.

E4Scientific theories are representations (global or detailed, more or less true, and always symbolic) of supposedly real objects.

E5The degree of truth of scientific theories can be found out (provisionally) only with the help of observations, experiments, and further theories.

These presuppositions belong to epistemological realism. The classical technologist was usually not only a realist but also a naive realist, in so far as he took his models of reality to be picture of it. The modern technologist, acquainted as he is with sophisticated but often artificial mathematical models of systems and processes, is still a realist but usually one of th critical variety. Indeed he realizes that our theories of factual items are not accurate

pictures but symbolic representations that fail to cover every detail and often, far from being deep, account only for some external features. (This is notably the case with black box theories, which involve only inputs and outputs; it is also the case with grey box theories, which include also internal states but no mechanisms at all.) The technologist knows that those theories are oversi–mplifications and also that they contain components lacking a real counter-part, such as the proverbial massless piston and the rational decision maker.

However, the critical realism inherent in technology is tempered and even distorted by a strong instrumentalist or pragmatic attitude--the normal attitude among persons intent on obtaining practical results rather than deep truths without obvious practical import. This pragmatic attitude is clear from the technologist's manner of dealing with both reality and our knowledge of it. Indeed, for him .

(a) reality, which is the object or referent of basic science, is the sum total of **resources** (natural and human), **artifacts** (inanimate or alive), and **waste products**; and.

(b) factual knowledge, which is the aim of basic research, is primarily a **means** for the control of the fragment of reality he is interested in.

In other words, whereas for a pure scientist an object of study is a **Ding an sich** existing by itself, th technologist is interested only in the **Ding fur uns,** that which it is in our power to create, control or destroy. And whereas to the scientist knowledge is an ultimate goal that does not require any justification, to the technologist it is an intermediate goal, i. e. something to be achieved only in order to be used as a means for attaining some practical goal. In other words, whereas the scientist looks for knowledge for the sake of knowing, the technologist looks for knowledge for the sake of doing. No wonder instrum-entalism has such a great appeal to both technologists and those philosophers who have consistently mistaken technology for pure science.

Because of that pragmatic attitude, the technologist will tend to disregard any sector of nature or of society that is not or does not promise to be converted into a resource or an artifact. For the same reason he is prone to push aside any sector of culture unlikely to be instrumental for achieving his goals. Which is all right as long as he tolerates whatever he disregards.

The pragmatic attitude towards knowledge is reflected, in particular, in the way the technologist treats the concept of truth. But this point deserves another section.

6. The Technologist and Truth, and Other Problems

Although in practice the technologist adopts the correspondence concep-

tion of truth as **adaequatio intellectus ad rem,** he will not always care for the truth of the propositions he handles. He will be interested in (sufficiently) true data, hypotheses, and theories only as long as they are or promise to be conductive to the desired outcomes. He will often prefer a simple half truth to a complex and deeper truth. Thus if two different models of the system of interest are equivalent or nearly so as far as the data are concerned, the technologist will pick the simplest to operate with. For example, if all his data concerning a certain probability distribution consist of the mean and the variance, he will probably choose a rectangular distribution or at most a bell shaped one.

He must proceed in this way because he is usually in a hurry to get useful results. Besides, any error made in neglecting some variable (or some decimal figure) is likely to be masked by the unpredictable disturbances his real system is bound to be subjected to. Unlike the physicist or the chemist, the technologist cannot protect his systems against shocks other than by building shock absorbing mechanisms into them, which of course is not always desirable.

For similar reasons the technologist will not prefer deep but involved theories when superficial ones will do. However, unless he is a pseudotechnologist, he won't shy away from complex and deep theories if they promise success. (For example he will make use of the quantum theory of solids in the design of solid state components, and he will employ genetics and the selective theory of evolution in obtaining improved varieties of corn.). The technologist, in sum, will adopt a mixture of critical realism and pragmatism, varying these ingredients according to his needs. And so he will seem to confirm now the one, now the other epistemology, while actually all he intends to do is to maximize his own efficiency regardless of philosophical loyalties. In short the technologist is an epistemological opportunist rather than a person of firm principles.

The technologist's opportunist conception of truth is just one, if major, epistemological component of technology. Let us mention two specific items of epistemology that have taken part in technological developments, one in education, the other in artificial intelligence. It is well known that pestalozzi's educational techniques were based on the slogan of British empiricism, namely "No concept without a percept". Likewise the philosophical basis of John Dewey's educational techniques was the pragmatist thesis" No concept without an action". As for the philosophy underlying artificial intelligence studies, it contains one major ontological hypothesis-namely

"Whatever behaves like an intelligent being is intelligent" and a batch of epistemological hypotheses, among them "Every perception is the acceptance of an external stimulus", and "Some spatial patterns are perceptible and discernible from one another". We shall abstain from commenting on these hypotheses: our aim was only to reinforce our thesis that technology has an epistemological background.

We wind up this section listing a few epistemological problems raised by technology.

EP1 Is it true that there are no specifically technological theories, e. g. in electronics, medicine, or management?

EP2 If the answer to the former question is in the negative, what are the peculiarities of technological theories in contrast to scientific theories?

EP3 In what do technological rules differ from scientific laws? (Take into account that some philosophers of science have conceived of scientific laws as rules.).

EP4 How can the notion of approximation be exactified and how do approximations affect deduction?

EP5 What is the basis for the prognoses made in technology and what is their function by contrast to that of scientific predictions?

EP6 How can one formalize in general terms the effect of the knowledge of a technological forecast on a course of action?

EP7 What is the basis for technology assessment?

EP8 Unlike physicists and biologists, engineers and managers often claim that they have to employ the personalist concept of probability (as degree of rational belief). Is this true or are they mistaking subjective estimates of objective probabilities for subjective probabilities?

EP9 one of the features of the mentally sound person is his/her capacity to see him/herself and others as they are. What is the difference between this psychological concept of objectivity and the philosophical concept?

EP10 What are the epistemological characteristics of the social indicators used in applied social science-e.g. development indicators and quality of life indicators?

So much for a random sample of interesting and hardly explored epistemological problems posed by technology. Let us now approach ontology of technology.

7. The Ontological Background of Technology

Technology inherits from basic science some of the latter's ontology and has in turn produced some remarkable metaphysics of its own. We shall

exhibit a few examples of each. Let us begin with the ontology that techn-ology shares with basic science. Here are some of its principles.

o1 There is a world external to the knowing and acting subject.

o2 The world is composed of things (material objects).

o3 Every property is possessed by some things: there are no properties or forms in themselves.

o4 Things get together in systems.

o5 Every system except the universe interacts with other systems in some respects and is isolated from other systems in other respects.

o6 Every thing is subject to change.

o7 Nothing comes out of nothing and nothing goes over into nothing.

o8 Every thing possesses objective patterns (laws).

o9 There are various types of law: causal and probabilistic, same level and cross-level, specific and general, etc.

o10 There are several levels of organization: physical, chemical, biol-ogical, social., technical, and perhaps others.

So much for the ontological hypotheses technological research and policy making share with scientific research. In addition to those general theses there are others which are specifically technological: some generic (embracing all branches of technology) and others specific or peculiar to certain branches of technology. Let us sample each of these populations of specifically techno-ontological hypotheses, starting with the former. Here is a sample:

(a) With the help of technology **man can alter certain natural or social processes** in a deliberate and planned fashion. (this thesis is not so obvious as it looks. Indeed, there are quietist onotologies in which man does not occur as a transforming agent.).

(b)Thanks to technology **man can create or destroy entire natural kinds** (e.g. biological species), thus enriching reality in certain respects and impoverishing it in others. (Nor is this a platitude, for in a religious world view man is not creator but creature.).

(c)Because artifacts are subject to human control or are equipped with control mechanisms that have not emerged spontaneously in a process of muta-tion and natural selection, they constitute **a distinct ontic level character-ized by properties and laws of its own**-whence the need for elaborating a techno-ontology besides the ontologies of the natural and the social sciences.

Let us now exhibit a small sample of the ontological hypotheses under-

lying the special technologies.

(d) Industrial chemistry-unlike mechanical engineering – presupposes and reinforces the hypothesis that **there are novelties,** i.e. that not every-thing new is just a mere rearrangement of preexisting entities.

(e)Agronomy and veterinary medicine presuppose and reinforce an evolutionary ontology. (But the evolution is of course directed not natural).

(f)Management science presupposes and reinforces a systemic view according to which social organization (factories, hospitals, schools, armies, etc.) are neither mere sets of individuals nor unanalyzable totalities.

In addition to presupposing a number of ontological hypotheses, technology poses new problems of the same kind. More on this anon.

8.Some problems in the Ontology of Technology

Let us now list a few ontological problems, most of them unseen heretofore, posed by the mere existence of technology.

OP1 Do artifacts possess peculiarities not shared by natural objects, aside from having been designed and manufactured by humans or by other artifacts controlled by humans?

OP2 Do artifacts and man-machine compounds have laws of their own different from those studied by basic science?

OP3 Do man-machine systems belong to an ontic level of their own? If so how is it related to the other levels?

OP4 Can one say of artifacts that they are embodiments or materializations of ideas?

OP5 What are the peculiarities of self-controlled artifacts **vis a vis** natural self-controlled systems such as organisms?

OP6 Is it possible that we may end up by being dominated by machines? (More basic: Can machines have a will of their own)

OP7 Is it possible to design a machine capable of posing or dodging original problems, and of doing good or evil of its own accord ?

OP8 Is there more than a mere analogy between the satisfactory functioning of an artifact and the health of an organism? And what is the general concept of health anyway?

OP9 What are the ontological assumptions concerning the mind underlying the various psychiatric therapies?

OP10 Do the applied social sciences and legislation presuppose any ontological hypotheses concerning the nature of the person and of society ?

Contemporary technology, far from just posing problems for the phil osopher, has given him a number of new theories: to wit, **general system theories.** These are high grade (though mathematically often simple) general theories such as automata theory, the general theory of machines, general network theory (concerning networks of any kind), control theory, and others. These theories may be placed in ontology as well as technology, and this for the following reasons. Firstly they are concerned with entire genera (rather than species of systems: they are cross-disciplinary theories, portable from one field to another. (Think of the variety of fields of application of automata theory and control theory, from engineering to biology.). Secondly these theories are stuff free or independent of the kind of material, hence independent of any particular physical or chemical laws. (They focus on structure and behavior rather than on specific composition and mechanism.). Thirdly these theories are not testable without further ado, because they generate no predictions. (But they can be made to issue projections and thus become testable upon conjoining them with items of specific information concerning the concrete systems they are applied to. However, in the process they cease being general theories.).

Let these brief remarks suffice for pointing out the existence of a big fish that went through the net of most contemporary philosophers, namely the set of ontotechnological theories created by engineers and applied mathematicians since the last world war. Metaphysics, banned from many philosophy departments, is alive and well in the schools of advanced technology. Let us now peep at another philosophical fact of technology.

9. Technoaxiology.

Every human action is value-oriented: if spontaneous, because it seeks to attain goals that are valuable to the agent; if deliberate, because every decision is preceded by a valuation. However, the objects of human action–the things upon which we act-need not always be valuable or disvaluable. In particular, to the scientist all concrete objects are equally worthy of study and devoid of value. If preferred, to the scientist **omne ens est bonum.** Not so to the technologist: he partitions reality into resources, artifacts, waste products, and the rest-the set of useless things. And he values artifacts more than resources and these in turn more than the rest. His , then, is not a value free cosmology but one resembling the value laden cosmology of primitive and archaic cultures. One example will suffice to bring this point home.

Call p and Q two components or two properties of a certain system of

technological interest. Assume that Q interfers with or inhibits p. If p. is desirable in the eyes of the technologist, then he will tend to call Q an **impurity,** or a **noise,** or something similar. And, unless the impurity or the noise is necessary for obtaining a third desirable item R (such as conductivity, or fluorescence, or a given color), the technologist will regard Q as a disvaluable item, hence one to be minimized or neutralized. To the scientist, on th other hand, Q may be interesting or uninteresting (for the time being) but never disvaluable. Of course Q may happen to be a nuisance, as is the case with a disturbance or a leak that interferes with the normal functioning of an apparatus or forces one to complicate his calculations. But in any case if it exists it is just as worthy of study as any other item, though perhaps not im mediately.

This value orientation of technological knowing and acting contrasts with the value neutrality of pure science. True, social science does not ignore values but accounts for them or at least is trying to. However, to pure science nothing is pure or impure in an axiological sense not even pollutants, not even value systems disagreeing with our own. In pure science valuation bears not on the objects of study but on research tools (e. g. measurement or computation techniques) and outcomes (e. g. data and theories). One lunar theory may be better (truer) than another, but the moon itself is neither good nor bad. Not so for the space scientists and those behing them: for them the moon, however barren, is (or was) good. In general, whereas the technologist evaluates everything, the scientist **qua** scientist evaluates only his own activity and its results. He approaches even valuation in a value free fashion.

The value orientation of technology gives the philosopher a splendid opportunity to analyze the valuation process in particular cases rather than setting up a priori or conventional value tables, or else waiting for the anthropologist to tell him, in more or less unclear terms, that all societies have value systems. Technology can even inspire the philosopher to build realistic axiologies, where valuation occurs as a human activity performed in a concrete sociohistorical context, partly rational and done in the light of definite antecedent knowledge and definite desiderata. As a matter of fact technology has already had an impact on value theory: utility theory (the theory of subjective value), though originally proposed as a psychological theory, has recently been revived and elaborated in response to the needs of economists and management scientists.

We wind up this section by listing a few open problems that pop up on our contemplating technology in the light of value theory.

AP1 What kind of values (or value functions) does the technologist handle: economic, social, political, cognitive, aesthetic, or moral?

AP2 Is it possible to aggregate the various values assigned to a technological object such as a project or an artifact?

AP3 What technological value indicators are the most reliable : benefit / cost ratio, time saved, or what ?

AP4 The values occurring in decision theory and its applications. (e. g. to engineering and to management) are subjective. Would it be possible and advantageous to replace them by objective values, such as the degree to which a basic need has been satisfied?

AP5 Which set (s) of axioms would constitute a satisfactory implicit definition or an objective value function (in contrast to the utility or subjective value)?

AP 6 The technologist lacking in social sensitivity, just like the polifition without scruples, may ignore the noxious side effects of the means he employs to attain his goals-or rather those of his employer. Would i t be possible and desirable to evaluate the means and the side effects, not just the ends?

AP7 Would it be possible to formulate decision rules based upon value theoretic theorems relating the values of the goals (and those of the side effects) to those of the means?

AP8 Technological decisions are made on the strength of both law (natural or social) and value judgements. Would it be possible and desirable to generalize this procedure to moral and legal issues?

AP9 How do value judgements intervene in the drawing up of urban development plans, or educational projects, or plans for the development of a nation?

AP10 Assuming that every member of a community assigns his/her own value to every measure with a social scope, is it possible to form the aggregate value for the community as a whole?

These brief lines will have to suffice to suggest the axiological richness of technology and to motivate some philosophers to improve upon the present state of conventional philosophical value theory, characterized by its technical

poverty. Let us now go over into the most obvious application of technoaxiology: technoethics.

1. The Moral Dilemma of the Technologist.

Both basic and technological research are supposed to abide by a code or intellectual honesty. For example, it is just as wrong to cheat in reporting on new industrial process as in reporting on an experiment in genetics. Also the theft of ideas is morally punishable in both cases although it is rather frequent practice.

But intellectual honesty, though an essential component of the morals of pure and applied research, is not the whole of it. To have a socially responsible moral code we must add at the very least the Golden Rule. This rule implies among others the Epicurean commandment enjoining us to minimize suffering, and the principle "My liberty ends where yours begins". These moral rules should suffice-though in fact they do not — to ensure the ethical control of scientific research.

Most basic research is harmless and therefore it poses hardly any moral problems. True, certain current investigations in genetics, virology and psychology could be misapplied, leading to disastrous consequences, perhaps for the whole of mankind. However, the above mentioned moral rules suffice, at least in principle, to avoid such perversions of knowledge. For example, in aversion and fear research mild torturing may be condoned provided it is done with the free consent of the experimental subject and if it can be safely predicted that it will not be traumatic. In short basic science needs only a mild external moral control.

The mildness of the moral structures needed to keep basic science on the road of wisdom is due to this : basic knowledge is **a good in itself** regardless of the ways in which it may be applied. For the human being knowledge is as vitally necessary as food, shelter, defense, feeling useful, loving and being loved. The good life, the **summum bonum,** cannot be conceived of today without knowledge, both useful and useless.

Things are different with technology. Here not only some of the ways and means of knowing may be impure: an entire technological process may be morally objectionable because it aims exclusively at evil practical goals. For example, it is wicked to conduct research into forest defoliation,

the poisoning of water reservoirs, the maiming of civilians, the manipulation of consumers or voters and the like for the knowledge gained in research of this kind is likely to be used for evil purposes and unlikely to serve good purposes. It is not just a matter of unexpected evil use of a neutral knowledge such as the knowledge of kindling a flame. **The technology of evil doing is itself evil.** The few valuable spinoffs it may deliver are by far outweighed by its negative output. Try and find a good use for the stocks of lethal germs accumulated for biological warfare, or for the rational organization of an extermination camp.

In short, technology-unlike basic science-can be either a blessing or a curse. (That it is always a blessing, if not in the short run then in the long run, is a tenet preached by a number of philosophers both on the left and on the the right, since the dawn of the Modern period. Other philosophers instead have claimed that technology is always a curse, but they have done so for the wrong reason-because they were against social progress and cultural expansion. It is only in recent years that most of us seem to have come to realize that technology itself, and not only its masters, can be good or evil.) Moreover we are learning that one and the same course of action guided by technology may have at the same time a good and an evil aspect. This being so we have got to subject technology to moral and social controls. Therefore it is necessary, nay urgent, that both technologists and moral philosophers devote more attention than heretofore to the problems of technoethics.

1. Technoethics.

I mean by **technoethics** the study of the moral codes inherent in the various branches of technology: those already adopted and those that oug o be adopted.

Every human activity can be controlled or criticized in the light of a behavior code which is partly moral and partly legal. In particular, the technological process has been guided or misguided by the following axiological or moral maxims:

(i) Man is separate from and more valuable than nature.

(ii) Man has the right (or even the duty) to subdue nature to his own individual or social benefit. (Remember Bacon's praise of **natura vexata** over **natura libera.**).

(iii) Man has no responsibilities towards nature: he may be his brother's keeper (or even prison warden) but he is not nature's nanny.

(iv)The supreme task of technology is to help attain the fullest exploit-- ation of natural and human resources-the unlimited increase in GNP-at the lowest possible cost without regard for anything else.

(v)Technologists and technicians are morally irresponsible Their duty is to carry out their task without being distracted by moral or aesthetic scruples. The latter are the exclusive responsibility of the policy makers, in particular the politicians.

These maxims constitute the core of the technoethics that has prevailed until recently in all industrial societies regardless of the type of social organization. Certainly those maxims are not justified by technology itself, let alone by basic science: rather, they have justified the uses and misuses of technology. Moreover they have not evolved within technology but within certain religious and sociopolitical ideologies, in particular those regarding industrial progress as an end rather than a means.

In recent years we have come to distrust or even reject altogether the above maxims because we have begun to realize that they condone the dark side of technology. But we have not offered a viable alternative moral code for technology, one **bridling technology without suffocating it.** It is high time philosophers of technology started helping build alternative technoethics, involving different desiderata and based upon our improved knowledge of both nature and society-knowledge of which was scanty at the time the old code was formulated, namely towards the beginning of the 17th century.

If we wish to keep most of modern technology and even improve upon it, while minimizing its evil components and negative side effects, we must design and try to enforce a moral code for technologists covering every technological process as well as its repercussions at both the individual and the social levels. Actually we have got to work on a set of three moral codes: a universal code, another one regulating the activity of the technologist, and a social moral code regulating the thought and action of policy and decision makers concerned with technology. To be more explicit, we need:

(i) a **universal moral code** for every human being, no matter what his or her station in life may be. This must of course be a viable code of conduct, not one designed exclusively for heroes or saints. And it should be based on value judgements that can be argued about rather than on dogmatic commandments.,

(ii) A set of **individual moral codes for the technologist as such** one for each branch of technology. These codes should include the moral code of basic science, i. e. the set of moral norms guarding the search for and dissemination of truth. But)they should also take into account the peculiar moral problems faced by the technologist bent on attaining noncognitive goals. These additional norms should emphasize the personal responsibility of the technologist in his or her professional work and his or her duty to decline taking part in any project aimed at antisocial goals. Finally these moral imperatives-or rather grounded rules-should be consistent with.

(iii) a **social moral code** regulating the formulation of technological research and development policies. Its norms should disallow the pursuit of socially undesirable goals and they should impose strict bounds on any technological processes that, while pursuing worthy goals, have severe negative side effects. This social moral code should be inspired in the basic needs of society rather than dictated by any of its groups:otherwise it would be unfair and it might not be enforceable-except by force of course. The gist of this code should be the norm : "Technological projects should be reasonable, feasible, and beneficial or at least indifferent to all the persons-alive or future-that could be affected by it".

Such a three tiered moral code, if enforced, would make it more difficult for the Dr. Jekyll/Mr. Hyde type of scientist to thrive. There would be no toleration of double or triple moral standards if there were no conflicting moral codes, one for the basic scientist, a second for the technologist, and a third for the policy maker. If we wish to control technology for the benefit of society as a whole we must se up and enforce a set of mutually consistent codes of behavior covering the entire broad spectrum of technology, from research through policy making to action. I submit that the technophilosopher has an important role to play in this endeavour-not as an infallible law-giver of course but as an expert participating in the discussions of technoethical projects.

12. Technopraxeology.

Praxeology is supposed to study human action in general, be it rational or irrational, good or evil. Actually there is no single and systematic descipline tackling that task: there is just a rather amorphous set of fragments taken from several fields. The study of **rational** action, though also scattered among various disciplines, is somewhat more advanced. Those disciplines are, among

others, human engineering, operations research, management science, military strategy, decision theory, and the young branch of philosophy known as action theory.

We need one more branch of praxeology, namely **technopraxeology,** or the study of technology-guided (or misguided) action. It is not a question of planning action-a task for technological experts-but of approaching philosophically the study of technological projects as well as their implementation.

Take for instance a plan for building or remodeling a city.Such a project, with so many different facets, calls for the cooperation of city planners, architects, civil engineers, geologists, geographers, sociologists, public health experts, and others. Why not throw in a philosopher as well? Unless he is an obscurantist or is insensitive to social questions, he may be helpful in various ways. For example, he may clarify a number of hazy notions-so frequent in the descriptive parts of the social sciences. He may also point out, here and there, that this precedes that, that such and such a course of action presupposes certain ideas that should be examined more closely, or that some of the goals of the project are compatible with a certain code of behavior-e. g. that of the builders-but not with other codes-e. g. that of the users. In short, technophilosophers can make themselves useful in interdisciplinary teamwork if only because clarity, not only time, is money.

But there are of course more basic or theoretical tasks awaiting the philosopher interested in contributing to technopraxeology. Here is a near random sample of problems the consideration of which might get technopraxeology off the ground.

TPP1 How can the general concept of action be exactified, and how the specific concept of rational action?

TPP2 How could one elucidate the concept of technology-guided action ?

TPP3 What is the degree of success of an action? Is it related to the probability of its outcome?

TPP4 How could one formalize the notion of degree of efficiency of an action (other than in decision theoretic terms, which may be too narrow for certain purposes)?

TPP5 What is the formal structure of a plan of action?

TPP6 In what manners do empirical knowledge, theories, and valuations take part in the drawing up of a technological project?

TPP7 How are technological projects evaluated or how should they be assessed: by certain intrinsic characteristics (e. g. solidity or elegance), by the benefits (individual or social) they may yield, or in what other manner?

TPP8 How can one characterize the system composed by the policy makers, the planners, the people in charge of implementing the plan, and the thing planned? (I. e., what kind of system is that?).

TPP9 Every plan is bound to exhibit defects in the course of its implementation. Is there a general way of generating flexible plans making room for corrections along the way?.

TPP 10 Planning from above may be technically impeccable but socially unrealistic or even noxious. Planning from below may be socially viable (though not necessarily beneficial) but technically incompetent. Is it possible and desirable to combine technocracy with democracy?.

May the preceding list of problems stimulate someone to create technopraxeology.

Conclusion: the Place of Technology in Contemporary Culture .

Like every culture, that of contemporary industrial societies is a system composed of interacting components, and it interacts strongly with the two other subsystems of society : the economy and the polity. The main components of our culture are shown schematically in Fig 2. On the ground floor we find the "hardest" or most rigorous components, namely mathematics and basic factual science. The next floor is occupied by somewhat " softer " components: technology and the humanities. Philosophy is in the very midst of these four areas and partially overlaps with them. Finally, th upper floor is occupied by the "soft" components, namely art and the ideologies.

Technology is the youngest component: maybe this is why we do not always realize how central it is to our culture. Far from being an outlying component of it, technology interacts vigorously with all the other components On the other hand art and ideology hardly interact with mathematics and pure science.) In fact technology and philosophy are the only component of living contemporary culture that interact strongly with all the others.

In particular, technology interacts with several branches of philosophy, among them epistemology, ontology, value theory, and ethics.,

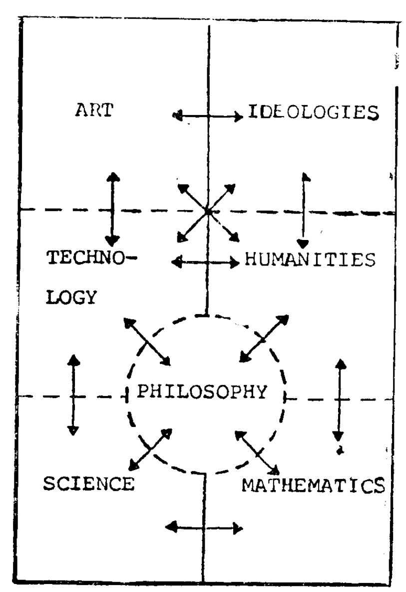


Fig. 2 — The system of contemporary culture. The dotted lines for imprecise borders. The arrows represent interactions.

Not only does technology interact with every other sector of contemporary culture, but it overlaps partially with some of them. Thus architecture and industrial design are in the intersection of technology and art. Much of physics and chemistry are as much engineering as they ar science· Genetics applied to agronomy and husbandry is hardly distinguishable from pure genetics. Medicine and veterinary medicine overlap and share much with biology. And even some of ontology is both philosophical and technological-remember the general theories of systems.

Like science, technology consumes, produces and circulates philosophical goods. Some of these are the same as those activated by science, others are peculiar to technology. Thus because of its emphasis on usefulness the epistemology of technology has a strong pragmatist streak and is therefore coarser than the epistemology of scientific research, On the other hand the ontology, axiology, ethics and praxeology of technology are richer than those of science.

Table 1. Some of the nearest neighbors of some branches of technology.

PROTOSCIENCE	SCIENCE	TECHNOLOGY	TECHNICAL PRAXIS	PSEUDO-TECHNOLOGY
Ancient & medieval physics & astronomy	Modern physics and astronomy	Physical engineerings	Engineering practice	Astrology
Ancient & medieval mineralogy & part of alchemy	Chemistry	Industrial chemistry & chem. engineering	Chemical engineering practice	Alchemy
Ancient & medieval natural history	Biology	Agronomy, veterinary medicine, dentistry, medicine	Agrotechnical & medical practices	Homeopathy, chiropractic, Lysenkoism
Philosophy of mind (part)	Psychology	Psychiatry, industrial Psychology	Drug & behavior therapy	Psychoanalysis, graphology
———	Economics	Economic & financial planning	Economic management	Economic miraclemanship
———	———	Information science	Computation & control	GIGO computering, blahblah systems analysis

In conclusion: because of the conceptual richness of technological processes and of the multiple contacts of technology with the other components of contemporary culture, the former is central to the latter. We cannot ignore the organic integration of technology with the rest of modern culture and regard technologists as skillful barbarians in need of some dose of culture. We cannot afford to ignore the nature of technology, let alone despise it, if we want to gain ful control over of technology, in order to prevent its misuses. Therefore we must build up all the disciplines dealing with technology, not least of them the philosophy of technology, the more so since it is often mistaken of the philosophy of science. The history, sociology, politology and psychology of technology tell us a lot about technologies and technologists, but only the philosophy of technology makes it its business to tell us what the methodological epistemological, ontological, axiological, and ethical pennants of technology look like.

IDEOLOGY AND SCIENCE*

MARIO BUNGE

In every culture men and women are inspired or oppressed by some ideology or other, be it total or only religious or sociopolitical. On the other hand only a few cultures have created science. Even very advanced civilizations, such as the ancient Egyptian, Indian and Chinese ones, were without science as we know it, i.e. as a self-correcting and self-sustaining cognitive enterprise. Moreover some societies have deliberately destroyed the little science they had inherited. Others have refused to adopt the science created elsewhere. Such hatred or fear of science has always been justified in the name of some ideology or other. For example, the religious fundamentalists-be they Christian or Moslem, Hindus or Buddhists-have rejected modern science as a whole; and the totalitarians, when in power, have banned entire scientific theories for being incompatible with their own dogmas.

These and other historical facts raise a number of interesting methodological and epistemological problems. The most interesting among them are: **(a)** What are the differences between ideology and science?; **(b)** is all ideology incompatible with science?, and **(c)** are scientific ideologies possible? Let us make a quick study of these problems.

1. Science:

We characterize factual (empirical) science as a whole (rather than a particular science), at any given time, as the 9-tuple:

SCI = "C, W, D, G, F, P, K, A, M", where.

C — The international community of scientific investigators.
W — The part of the world that tolerates C.
D — The domain of facts (or universe of discourse) studied by SCI.
G — The general outlook, or world view, or philosophy held by the members of C in their capacity as researchers.
F — The formal background of SCI, i.e. the totality of logical and mathematical theories known at the given time.
P — The scientific problematics, i.e. the collection of cognitive problems that can be handled scientifically at the given time.

* This lecture was delivered on December, 22 · 1983.

K — The body of scientific knowledge (i.e. the collection of data, hypotheses, theories, and methods) available at the given time.

A — The aims of scientific research-i.e. the discovery or utilization of objective laws and true theories capable of systematizing, explaining or predicting.

M — The methodics, or collection of all methods (in the first place the scientific method) utilizable in SCI.

The precise membership of every one of the nine coordinates of SCI changes in the course of time: science is essentially evolutionary. Moreover this evolution of scientific knowledge is the result of research not of external pressures: the latter can only accelerate or slow down a research process that has an internal dynamics-that of posing problems ,advancing hypotheses, and subjecting the latter to the test. Another characteristic of science that it constitutes a system every subsystem of which-e.g. physics and social science-is tightly connected to some other subsystem of science. (If a discipline makes no contact with other disciplines then it is not a science.) Finally modern science is the basis of modern technology: the latter remains stagnan unless it feeds from the former. (Practical consequence: a country without original science is forced to import its technology and thus to remain dependent upon the highly industrialized countries, all of which have a creative technology based upon modern science.) The link between science and technology is so strong, that one should speak of the science-technology supersystem. And the importance of this system in advanced societies is such, that it has become the center and source of their intellectual cultures.

Every body of knowledge, be it genuine or illusory, is accompanied by a value system, i.e. a set of value judgments. This value system stimulates or inhibits the thoughts and activities, of the individuals involved in enriching, diffusing or preserving the body of knowledge in question. The value system of science includes such logical values as exactness, systemicity and logical consistency; semantical values such as meaning definiteness (hence clarity) and maximal truth (or adequacy of ideas to facts); and methodological values such as testability and the possiblity of scrutinizing and justifying the very methods employed to put ideas to the test. On the other hand the value system of technology includes, in addition, such values as practical applicability, versatility, reliability, and cost efficiency. In both cases such value systems are tacit rather than explicit: they are taken for granted or presupposed. On the other hand values are openly declared by every ideology: they are part and parcel of the very definition of an ideology-on which more anon.

2. Ideology:

Whereas the essence of science is research, that of ideology is belief. In fact an ideology may be characterized as a system of beliefs, in particular value judgments and statements of goals. It may also be construed as a social group united by such beliefs, values, and goals. More precisely, an ideology may be analyzed as the 11-tuple.

IDEO = "C, S, D, G, F, B, P, K, V, A, M",

where at any given time.

C — The community of believers (in particular militants) in IDEO.

S — The society that tolerates C.

D — The domain of objects (real or imaginary) studied or handled by members of C as believers in IDEO.

G — The general outlook, or world view, or philosophy adopted by the members of C.

F — The formal background admitted by IDEO.

B — The factual background (the body of factual or empirical knowledge) admitted by IDEO.

P — The problematics or collection of problems handled by members of c.

K — The fund of knowledge (genuine or illusory) held by the members of c.

V — The value system shared by the members of C.

A — The aims of IDEO-e.g. personal salvation, or the establishment of a new society of a certain kind.

M — The methods deemed to be suitable to attain the A's.

The analogies between ideology and science are obvious: in both cases we have communities of practitioners; societies that now stimulate, now inhibit the thoughts and activities of those practitioners: a universe of discourse or objects (or referents) that are thought about; a general outlook; a collection of formal (logical or mathematical(tools; a collection of problems; a fund of knowledge; a collection of goals; and a set of means or methods supposed to help attain such goals. The only ostensible differences between IDEO and SCI would seem to be B and V. In fact, although every factual science other than physics presupposes some other factual science, the totality of sciences, i.e. the system SCI, takes only formal science (logic and mathematics, i.e. F) for granted; on the other hand IDEO presupposes (does not question) ordinary

knowledge; and, as we shall see below, it is possible for an ideology to take some science for granted. As for V, we saw in Sect. I that science has a tacit value system, whereas an ideology declares its values. So, at first sight the only difference between IDEO and SCI would seem to lie in that the former has two more coordinates than the latter, namely B and V. However, this is a superficial impression.

In fact, the differences between science and ideology are many and profound, as one realizes upon examining the content of the components that define them. To begin with, whereas the members of a scientific community are inquirers, those of an ideology are basically believers. Second, whereas the scientific community is nowadays truly international, all ideologies are geographically circumscribed. Third, most ideologies include in their domain of discourse D objects the existence of which cannot be established by scientific means; as a compensation, science includes in D objects-such as quarks and aphasias-that are of no interest whatever to any ideology. Fourth, unlike most ideologies, the philosophy G inherent in science includes **(a)** an ontology of concrete changing and lawful things; **(b)** an epistemology that recognizes the power of both reason and experience but denies the validating power of authority, intuition, and revelation; and **(c)** the ethos of the free search for truth, regardless of vested interests and received opinions.

A fifth difference between SCI and IDEO is that, whereas the former admits the totality of (ordinary) logic and (classical) mathematics, the F of IDEO is far more modest and in certain cases nil. (In particular, mysticism and Nazism reject logic altogether.) Sixth, most ideologies admit only ordinary knowledge, which for science is only a point of departure. Seventh, most of the problems handled by IDEO are practical rather than theoretical: in this respect ideology is closer to technology than to science. Eighth, most ideologies include myths in their fund of knowledge-e.g. the myth of the chosen race or class. Ninth, the values of an ideology are not those of science: the former are moral (e.g. purity) or practical (e.g. eternal life), whereas the latter are strictly cognitive (e.g. truth and depth). Tenth, whereas the aims of SCI are strictly cognitive-to understand reality-those of IDEO are strictly practical-to attain some personal or social advantage. Eleventh, some ideologies utilize methods (such as prayer and incantation) at variance with science; and others resort to actions(e.g. legislation andimass movement) alien to scientific practice. In short,the methodsoị of SCI and of IDEO are mutually disjoint.

It would seem, then, that science and ideology are not just alien to one another but even mutually incompatible or inimical. However, this is not what we have established so far: we have only shown that they are quite different. The question whether a scientific ideology is conceivable will be tackled in Sect.5. Our immediate concern is with a more idetailed analysis of the concept of an ideology.

3. Three kinds of Ideology

So far we have dealt with the whole family of idealogies-actual or conceivable-and their differences with science. We shall now proceed to distinguish three genera of ideology: total, religious, and sociopolitical.

A **total** (or **global**)ideology may be analyzed as an 11-tuple
IDEO — C,S,D,G,F,B,P,K,V,A,M.

Where only the key coordinates will be listed explicitly:

D -The totality of objects (real or imaginary) referred to

G - A total world view embracing nature and society, and possibly also the supernatural

P - A collection of problems, cognitive and practical, concerning members of D

V - A set of value judgments about natural and social objects, and possibly also supernatural ones.

A - A collection of cognitive, moral and practical aims.

The so-called great religions and Marxism are clear cases of global ideologies: they propose answers to questions of a great many kinds; ii.e. they contain world views supposed to accomodate all facts and to help attain a variety of goals-cultural, political, and others,. The main differences between great religions and Marxism lie not so much in scope as in content. Whereas Marxism is naturalistic and therefore secularistic, the so-called great religions are supernaturalistic and, at least in the past, they have encouraged theocratic regimes.

Nowadays most religions do not offer a comprehensive world view ; they have come to terms with modern society and have accordingly adopted a far more modest scope They are concer ned only with other-worldly matters and with their own organization, leaving everything else to the secular state and to science, technology, and the humanities. Cut to this more modest size, **a religious ideology** may be analyzed as an 11-tuple

REL – C,S,D,G,F,B,P,K,V.,A,M

where, at any given time,

C Church, or group of believers and militants, tolerated by a society

D Nature, society, and supernature

G Theology, or a collection of myths and dogmas about the supernatural and our relations to it

F At most intuitive logic, never mathematics

B At best ordinary knowledge, never scientific knowledge

P Theological and practical problems and mysteries con cerning personal salvation, the life of the church, and its relations with the rest of society

(in particular the secular power).

K A system of beliefs that are typically untestable or incompatible with modern science – ie.g. belief in miracles or in eternal life

V A value system headed by the beliefs that the divine is the highest value, and that man's supreme duty is to worship it

A A collection of aims including the attainment of eternal life (individual or cosmic) and the welfare of the church

M A collection of practices, such as fasting, prayer, exorcism, and possibly also the use of force prevail on the enemy.

As noted above, most churches have stopped fighting science: their faithful have tacitly adopted the medieval doctrine of the double truth. (See however Sect. 4 for the fundamentalist sects.) Nevertheless, this is truce, not peace, because religion is incompatible with science. True, some distinguished scientists are deeply religious-but not at the same time Experimentalists and theoreticians, no matter how religious they may be at home, do not abide by the dogmas and precepts of their religion when making measurements or calculations: if they did, they would fail to do science and they would be universally regarded as cranks.

To realize that religion and science are mutually exclusive it will suffice to note the following peculiarities of religion **vis – à – vis** science: **(a)** the members of church are united by common beliefs and practices rather than by the pursuit of Knowledge;**(b)** those beliefs include dogmas about supernatural entities which, by definition, are beyond the reach of science; (c) religious thinking makes no use of mathematics, except possibly in the guise of groundless numerology; **(d)** religion makes no use of any scientific knowl

edge–rather on the contrary, many a religious dogma has been refuted by scientific research, as are the cases with the beliefs in an immaterial soul) independent of the brain, and in the special creation of biological species; **(e)** theology, however liberal, contains dogmas rather than corrigible data **(f)** a religious value system is dominated by belief in supernatural entities rather than relying on the power of man to attain truth through research; **(g)** the effectiveness of religious practices–such as offerings and prayer–has never been established empirically; **(h)** religious faith relies on authority revelation, and the state of grace, neither of which is acceptable in science. In sum, religion is not just different from science but antithetical to it.

Finally, an **ideology**- such as liberalism, fascism,or socialism may be analyzed as an 11-tuple

SOCPOLIDEO — "C, S, D, G, F, B, P, K, V, A, M",

where, at any given moment,

C —Political party and its sympathizers

D —Society and its subsystems

G — A conception of society

F — Usually only intuitive logic, potentially all of mathematics

B — Usually only ordinary knowledge, potentially the whole of social science

P —Problems concerning the struggle for power and the management of social systems (in particular the polity)

K —A collection of social action programs (e. g. on how to control inflation or how to improve public health)

V —A value system concerning the good society as well as the right social behavior

A —A set of short, middle and long run goals to be attained by C

M — A set of means, mostly practical, for achieving A

Note that, although every sociopolitical ideology has secular goals, it may be inspired by a religious ideology. For example, the ultimate practical aim of a church may be to establish a theocratic state. It should also be noted that, unlike religions, sociopolitical ideologies are not necessarily unscientific. Thus in principle it is possible for the back ground knowledge B of a sociopolitical ideology to equal the social science of its time. More on this in Sect. 5.

4. Fundamentalist Ideologies:

An ideology will be said to be **fundamentalist** if, and only if, it holds on to an unchangeable general outlook G, background knowledge B, fund of knowledge K, value system V, aims A, and methods M. Usually all these items are formulated in certain canonical texts, such as the **Bible** or a political manifesto. Clearly, ideologies of any scope-total, religious, or sociopolitical-can be fundamentalist. Contemporary examples of religious fundamentalism are the Christian and Moslem sects that adopt a literal reading of the **Bible** and the **Koran** respectively. Economic liberalism, which takes Adam Smith as its prophet, and dogmatic Marxism, are instances of sociopolitical fundamentalism.

The trademark of fundamentalism is rigidity, i.e. the refusal to admit any doctrinal changes. The fundamentalist seeks answers to all problems, however new, in his old texts. He claims that these texts are true and teach the right conduct in every circumstance, regardless of the enormous and quick changes he sees around himself. Whenever facts seem to refute his doctrine, or to call for a change in aims or in means, the fundamentalist attempts to reinterpret his canonical writings or to twist his facts. He believes firmly that, when rightly interpreted, the doctrine can never fail him: only the interpreter may be in error. Thus defeat results not in revising the doctrine but in reinterpreting it or in blaming the interpreter.

Whereas science is essentially revisionist, fundamentalist ideologies are conceptually conservative even when they preach radical social changes. (And, because the world and our knowledge of it change constantly, fundamentalist sociopolitical ideologies are inefficient tools for changing the world for the better.). Because of its rigidity, fundamentalism-whether total, religious or sociopolitical-is the polar opposite of science, which changes relentlessly as a result of research. The only way an ideology can coexist with science is by weakening its dogmas or giving them up every time they enter in conflict with science. Fundamentalism, both in religion and in politics, is often a backlash against such concessions. After all, the fundamentalist is right: if a doctrine is watered down to keep up with the advancement of knowledge, it soon ceases to resemble the original doctrine that inspired the church or the party.

In short, fundamentalism and science are mutually exclusive. Hence a consistent fundamentalist will fight any attempt to make science the center

of intellectual culture. Of course he may tolerate some measure of technology: he will not wish to part with his TV set, his car, or his medical services. But since creative technology depends largely upon original scientific research, in practice the fundamentalist will favor the importation of ready-made goods and, thus, the continuation or worsening of a colonial status.

5. Scientific Ideology?

In common parlance, 'scientific ideology' is a contradiction in terms. But our definitions in Sects. 1 and 2 have introduced technical concepts of science and of ideology which are not necessarily antithetical. To be sure a religious ideology cannot be scientific, because the general outlook (or world view) of religion includes supernatural entities and paranormal modes of congnition that are not admitted by science. On the other hand a sociopolitical ideology can be scientific.

We define a **scientific sociopolitical ideology as** the 11-tuple.

SCISOCPOLIDEO — "C, S, D, G, F, B, P, K, V, A, M),

where, at any given time.

C — Lay political party and its sympathizers.

D — Society and its subsystems.

G — The world view of science and, in particular, the general conception of society inherent in the social sciences of the time.

F — The whole panoply of logical and mathematical tools that may be needed to build theories and plans

B — The whole of social science (anthropology, sociology, economics., politology, and history)

P — Problems concerning the struggle for power and the administration of political, economic, and cultural systems

K — A collection of plans of social action (e. g. social programs) consistent with both G and B

V — A value system concerning the good society, as well as the right social behavior, consistent with both G and B

A — set of feasible short, middle and long term goals to be attained by c

M — A set of means deemed (in the light of B) adequate to attain A.

In short, a scientific sociopolitical ideology is one inspired in science rather than myth–moreover in current science instead of obsolete science. The science in question is social not natural:biology and psychology are to be taken granted but they only place constraints on possible behavior patterns.

An ideology based only on our knowledge of social insects would be disastrous, and using only our scant knowledge of individual psychology would be inefficient.

There is nothing good, except conceptually, about scientific ideology. Such an ideolgy may be good or bad, according as it includes admirable or scientific contemptible values, goals, and means.In other words, being scientific be only necessary for an ideology to be admissible A good scieotific ideology will be controlled not only by the best social science available but also by a doctrine capable of justifying (giving good reasons for) the values, goals and means included in the ideology. Consequently, rather than looking at ideologies separately from other cultural objects, we should evaluate them in the light of both social science and ethics.

In conclusion, scientific sociopolitical ideologies are conceivable. Whether they will eventually be built is another matter.

6. Conclusion

It is no secret that social behavior of some important kinds is inspired in ideology. This explains why so much has been written about particular ideologies. But it does not explain why the general concept of an ideology has received scant attention, particularly on the part of exact philosophers.

Nor is it a secret that science is now constrained, now stimulated by ideology. Nevertheless we lack a detailed study of the relations between science and ideology. Worse: some philosophers hold that science is one more ideology.

In this paper we have attempted to define the concept of an ideology. We have distinguished ideologies of three scopes: total, religious, and sociopolitical. We have sketched the conceptual conflict between religion and science, and have defined the notion of a scientific sociopolitical ideology.

Our examination of the problems we have tackled has been cursory. It is intended only as a methodological preliminary to a scientific study of some of the most influential ideologies. (If we wish to understand ideology we must study it scientifically. An ideological approach to science would only distort the latter. In particular, science studies religion in an irreligious fashion, whereas religion is incompetent to study science.) Our analysis may also be of some help in building scientific sociopolitical ideologies–or at least in showing that such enterprise is logically possible.

SOCIAL JUSTICE AND THE POLITICAL GOOD*

VENANT CAUCHY

1

Theories of society such as those of Hobbes, Rousseau and Freud consider, in varying degrees, the person and the state to be antagonistic entities. The identification of right with might which many view as inevitable reduces justice, social justice, to something less than the ideal envisaged by Plato. Justice amounts to little more in this view than a leftover after the requirements of greed and ambition have been satisfied by the powerful.

Such theories are sometimes defended as following from realistic appraisals of the human condition. Similarly, in Roman times, candidates for high political office were thought less likely to plunder the people of Rome if they had already been given the opportunity to amass large fortune at the expense of provincial and dependent populations.

Pascal realised that little could be done about this in the autocratic societies of his time. «Si l'on avait pu, he writes (*Pensées*, sect.XIV,878), l'on aurait mis la force entre les mains de la justice : mais comme la force ne se laisse pas manier comme on veut, parce que c'est une qualité palpable, au lieu que la justice est une qualité spirituelle dont on dispose comme on veut, on appelle juste ce qu'il est force d'observer». Power, which the state possesses to promote the human development of persons, becomes an instrument for achieving the satisfaction of private ends on the part of individuals or of limited groups. Many people within civil society perceive the state as an entity which dispenses countless privileges and advantages to a select minority. Indeed too few have access benefits such as higher education, good health services, artistic enjoyment, leisure and other advantages made possible social life. In times of economic stress, the search for stability practically always involves worsening the plight of the poor, increasing their numbers by raising the cost of living and reducing or stabilising already marginal incomes, while at the same time increasing high-

* This lecture was delivered en March, 2, 1984.

incomes by providing taxes and other incentives purportedly meant to foster or maintain employment levels. Ironically, intolerable disparities, by virtue of which the few have everything and increasing numbers are progressively deprived of the bare essentials of life are defended and aggravated by pointing to the need to provide employment and to alleviate poverty.

However the purpose of political society consists manifestly in establishing ways of living with others which allow persons to actualise their capabilities, congitive and affective, as human beings. It should translate into positive social structures and practices characterised by an enlightened exercise of freedom and institutional networks adapted to the fulfillment of the potentialities of persons.

Thus conceived society cannot appear antagonistic to persons or threaten the achievement of their fundamental aims. That such propositions should seem unrealistic or utopian merely indicates the imperfect and, in many cases, perverse condition of societies as they existed or as they exist in our own day.

To sum up, three basic points need to be made in considering what is required for society to serve its purpose. First it must be founded on the primacy of persons, of their development and activity as persons. Second a political society instituting this primacy in its structures cannot be hostile to persons or alienate them; this applies as well to intermediate societies which mediate the relations of persons to the total society. Thirdly the deviations which afflict societies and render them illegitimate are due in large part to the abusive manner in which governments, at various levels, tend to conceive the ends of social life and to use the powers they hold over persons.

II

In a previous paper, I was concerned primarily with distinguishing among various types of societies. The *state* or *political society* requires a territory and some kind of authority coordinating and unifying the activities of its people towards the achievement of the basic political good. Given however the manner in which states have been formed historically, various racially and culturally differentiated groups subsist within it. On type of constituent entity, the *nation*, can be defined as a society of human beings sharing a sense of belonging and more or less conscius of a common cultural heritage, traditions, history considered eminently worthy of perpetuation. The social group designated as a *community* on the other hand involves proximity, a sense of closeness

among its members. It tends to be samaller, more responsive to personal everyday needs and are supportive in ordinary or critical situations than the state or the nation. It is perceived synchronically rather than diachronically. The extension of the whole world arises from an awareness of shrinking spatial limits, of mutual need and dependence, of increasing closeness.

Smaller social groups, natural or artificial, mediate the needs of persons with respect to the larger political society. A rationally ordered state should seek wherever possible the mediation of the nation and of the community in dealing with its citizens, and thus should strive to strengthen national and communal bonds to improve its services to persons. Just as the more restricted societies result from the needs and aspirations of persons and as such cannot really be antagonistic to their constituents, so they cannot be fundamentally opposed to one another, nor need the larger society be hostile to them.

Where the state involves a diversity of national groups and communities, the legitimacy of such groups as natural loci of development of the whole person imposes upon the State an obligation to respect the nations and communities within its boundaries and to provide for their continued existence and expression. Otherwise a State ceases to be legitimate, since its basic responsibilities to the persons it exists to aid in their search for the fullness of human living cannot be at odds with their national identity or their sense of belonging to a community. I needn't here belabor the point that social justice involves much more in this regard than a mere consideration of the persons as separate entities in their relations to the state. The same can be said on the one hand about families and other smaller societies among themselves and in relation to national societies, and on the other hand about nations and states among themselves and in their relations with the international sphere.

The ideal sought after throughout the various social organisations and which social justice in its broader definition is meant to bring about is peace, not a social condition imposed as the only alternative to death total chaos and predicated on domination, submission, conquest, contempt, exclusion or discrimination. The satisfaction of closeness, the joy of mutual understanding and sharing in a true society, large or small, does not imply rejection or hatred of other groups. Rather as any society fulfills its essential purpose of fostering personal development it should increase one's propensity to appreciate the value of analogous societies to other persons. Thatand that alone represents the morally viable and acceptable outgrowth of a person's sense of belonging to a national group,

to a community or a state. The countless regrettable inversions and deviations of national sentiment, which history unfolds before our eyes in various forms such as racial discrimination, genocide, enslavement, colonia lism, testify to a cultural backwardness which we all share to some extent and which runs counter to the basic requirements of the humanity within us.

III

Before attempting a broad description of what social justice involves, I propose to examine briefly some of the behaviours and attitudes prescribed within a given society and which are thought to further or express the «interest» of the political whole. We generally know what we mean by «interests», though of course interests, individual, political, national, religious, commercial or otherwise, may be legitimate or illegitimate, moral or immoral, moderate or excessive, socially viable or utopian, acceptable or unacceptable. Interests are multiple and protean; they vary with the persons or groups perceiving them. Their being formally defined in the laws of a state or consciously pursued by a majority of citizens or by the rulers does not necessarily make them legitimate in a moral sense. It seems however that whatever contributes positively to the distinctiveness of the culture or cultures of the human groups within a state merits preservation and that its preservation can be considered to be in the interest of the political society. It matters little whether this be defined by law. Indeed no system of laws can be so thorough as to cover such a range and multiplicity of interests. The type of legal system itself, inasmuch as it remains sufficiently flexible to accommodate social change, is just one of the distinctive features which deserve to be preserved in the interest of political societies. One may say more correctly that laws are formally enunciated to reflect the spirit and ethos of the society to which they are meant to apply. The laws fit social needs inasmuch as they correspond to already existing social interests, provided of course interests are defined in fundamental human terms(1).

A basic right is that of living space(2). It can easily be overlooked precisely because it is so basic. Extended to the state, the entitlement to living space becomes a vital political interest, perhaps the most vital. However we have to recognize its precariousness in the present state of moral and social evolution. This right has been questioned and denied repeatedly throughout history, in many cases by people who were at the same time appealing to the right itself, as in Haushofer's notorious *Lebensraum* justification of Nazi conquests.

More basically still, even the right to live or to be free within the bounds of social obligations has been questioned and violated over and over again. Whole societies have risen against neighbouring societies denying them their freedom or the pursuit of human fulfillment. In other cases the power of the state has been abused to such a degree that the distinctive cultures of national groups within it have been diminished or abolished, depriving the persons belonging to such groups of the mediation of cultural values so vital to their personal development and to their harmonious insertion in the political whole.

We are all, in one form or another, perpetrators of cultural and historical injustices which cannot be undone. Whatever our status, as perpetrators, or their heirs, we are obligated to set right that which can be set right. But more importantly, we must seek to avoid the perpetration of further injustices. Indeed the problem rarely consists in the failure to claim a right for oneself, but in the readiness to acknowledge and respect the rights of others.

The sense of social justice is a disposition to act in a moral way in situations which arise in social interrelations. It is not natural state. Human beings possess intellectual capacities and feelings which initially make possible primitive choices where moral responsibility is quite minimal. To speak of a natural state of uprightness can only generate pessimism, since the imperfection, blemishes and strains evident in our slowly evolving ethical attitudes tend to appear, on such a presupposition, as a fall from some original state of perfection. In the beginning we are only potenial moral agents; any constancy in our disposition to act justly work unila- human quality gradually established by successive free choices involving responsibility and moral creativity.

The recognition of human dignity is an important condition for establishing social justice. Such recognition and respect cannot work unilaterally. The sense of cultural superiority, hence the tendency to depreciate other cultures, shows a lack of awareness of what constitutes human dignity. If one fails to recognize it in others, can one really recognize it in oneself ? Transposed to political and national entities, the failure to recognize the rights of other nations to exist and develop, the failure to value them for what they are, involves in a very real sense an incapacity to understand the value and dignity of one's own society. The various forms of colonialism and imperialism predicated on such superiority are consequently based upon ignorance of what constitutes the value and dignity of a social group. If one could but establish a practical correlation between the recognition of one's own human dignity and the recognition of the dignity of others in

interpersonal as well as international relations one would have come a long way towards living in a fully human way.

Genuine political interest cannot run counter to the legitimate interests of other states or nations. The recognition of this however involves fundamental changes in persons and societies. The political and national interest embodies the good as perceived by a people and reflected in its ethos. It does not have to conflict with the genuine interest of other peoples, no more than a recognition of one's dignity as a person conflicts with recognition of the dignity of others.

This of course is an ideal, approximated with difficulty, and rarely attained with some measure of perfection. However the ideal, cultural as well as personal, gives meaning and direction to change. Social interests are not easy to determine. Their formulation is often manipulated and abused to cover unworthy purposes. But their legitimacy involves their being perceived as compatible with respect to the dignity of other selves and social groups. That is, in the final analysis, essential to the definition of social justice.

IV

Social justice, the justice peculiar to social activity and social relations, involves two terms : the person and the society. Persons are directly affected by social justice or the lack of it. Its very nature in social affairs consists in the rectitude of social institutions, laws and practices responsive to the basic physical and spirtual needs of persons. The various levels of society on the other hand can be termed just or unjust inasmuch as their structures and practices reveal their fitness or unfitness to foster the achievement of the fundamental aims of persons.

The question is often raised whether the attainment of social justice requires primarily a change in persons or a change in society. Neither suffices by itself. We know only too well that the best constitutions or institutions mean very little by themselves if the people who make up the society are not profoundly imbued with a sense of respect for human dignity, and also that the best of persons can achieve very little in a society with insufficiently developed institutions and deficient laws. Both go hand in hand, though one is bound to precede the other, depending on the persons or the social groups considered. The change may be initiated largely in the society and filter down to the persons, or it may begin with persons and gradually permeate the society.

Considered as an ideal, social justice seems utopian and unreal. Real societies lack in some measure the determination to institute the social means necessary to respond fully to the needs of persons. The establishment of societies capable of ensuring the existence and optimal development of persons and groups proves more difficult than it might appear at first glance. One might believe for example that social justice involves substantial equality of persons in their claims to material and spiritual goods, relative equality in remuneration and taxation, public property of the land and of the means of production etc. If it should happen however that private ownership of land and industry, tax incentives for certain types of investments, significantly higher salaries for medical doctors, scientists, administrators etc. result in a more roductive, skilled and prosperous society, a society in which the less favored are better off in absolute terms than they would be in an egalitarian society, what are we to conclude? Should everyone be relatively hard up together, or is it preferable to allow inequalities in terms of which the least advantaged are better off than they would be in another type of society? Perhaps personal moral evolution can eventually bring about a situation in which more social equality is possible without diminishing personal initiative and creativity, hence without making the society as a whole less productive. In any case it seems evident that those who profit the most from inequality will continue to defend the more liberal conception of society.

Soical justice therefore does not necessarily involve strict equality in the material goods made available to everyone inasmuch as each person has access to whatever is needed for a life consonant with the standard set within the society. The principle here is that of the primacy of the person. If at a given time and place, a better life is made possible for persons in a given social system, then that system should be favored and no abstract consideration, divorced from the genuine good of persons, should prevail. If a liberal system is thus instituted, one should attend to the possible political abuses inherent in the accumulation of wealth and power by a few! If a socialist system is established, special care should be taken not to allow state regulation of various activities to deprive persons of freedom and creativity.

As indicated previously, social justice applies not only to the relations between the state and the persons, but also to the relations between the state and the family, the state and national societies, religious societies, cities and other less basic but legitimate groups such as commercial or industrial societies. Each has a reasonable claim to existence and development within the confines of the total society. It would be socially unjust

for Instance for a government to favour groups to which persons in authority belong.

V

Social justice then can only be correctly defined in terms of the nature of social reality. Society is not an absolute. It consists of persons interrelated and interacting to live better and to develop their human capabilities to the fullest extent. When the social reality no longer corresponds to the needs of evolving persons, new social structures better adapted to personal expectations need to be put in place. Social reality therefore is a function of the basic needs of persons successively determined according to the stage of development achieved. The social reality of a given age involves a conception of social justice which may be basically defective in comparison with the social reality of another age. Inasmuch as human beings and societies evolve, they are bound to achieve a better life; societies strive to make available to their members, as a matter of course, better and more institutionalised means of achieving personal development. It may not have been a social injustice. in the Middle Ages not to make basic education readily available to all people, but it has certainly become so in our modern societies. In the same way plitical and religious freedom, scientific and techological knowledge, aesthetic enjoyment are benefits which an advanced modern society makes available to all its members as a matter of social justice.

Social justice indeed determines the material and spiritual goods which society as a whole is obligated to make available to its constituent persons and groups. In this sense it regulates the behavior of any person or group in society with respect to others. Thus any person or group of persons has a claim to physical existence, integrity and growth; this involves a right to living space, to food, clothing, shelter, to normal human relations, to protection against dangers and threats, to proper medical care. On the spiritual side, persons and groups are entitled to a humane environment, to adequate information and training, to participation in the social and political activities, to aesthetic and litterary expression, scientific research, religious activity and finally to the full use of freedom as the distinctive mode of all human activity. Persons join together in societies in order to satisfy at least implicitly such claims.

Though societies and state are constituted to fulfil those needs, their very basis in human aspirations tends to be forgotten. Any society (even the least affluent), by uniting a multitude of persons, puts under the con-

trol of its leaders an abundance of goods and powers of great magnitude which can easily be deviated from their social ends and made to serve the ends of pride, egotism and greed. They may be used by a leader against his people, by one social group or family against another. The resources of the whole society may be allotted unjustly to one person, family or social group by personal edict or by legislation. This may come about through negligence on the part of the judiciary or the legislative powers, or by explicit legislation.

I spoke in rather theoretical terms of the need to base our choice of a social system on the requirements of the person. The choice cannot be effected without cosidering the capacity of the system to respond to personal needs. We have to recognize however that the liberal type of society with its emphasis on free enterprise has put us in a quandary as far as social justice is concerned. The productive capacities are obviously there, the needs and the capacity to consume also. But individual initiative and the profit motivation without proper ethical attitudes cannot insure the right functioning of society to respond to the needs and expectations of persons. On the other hand, we cannot resort to the establishment of social structures limiting the freedom of persons to act autonomously, to move around freely, to seek fulfillment in activites of their own choosing. It seems clear that this would run counter to the very end of society which is to ensure the fullness of personal life.

The great depression of the thirties dealt a severe blow to the principle that unbridled free initiative would always somehow work out for the benefit of society as a whole. Individuals were allowed for purely personal ends to make decisions affecting the material and spiritual integrity of whole populations. Social practice has evolved since then. The possible abuses of capital have been tempered by social laws instituting employment practices, unemployment insurance, housing and rent regulation etc. But we find again that this is not enough. Changing moods are allowed too much impact on the conditions of social life. Confidence or the lack of it strengthens or depresses the economy; interest rates rise or sink; jobs are lost, salaries are cut, creating the so-called «nouveaux pauvres» of affluent states. Surely the ideal of rationality in social and economic life would require a search for new forms of relating to one another which preserve freedom while at the same time allowing for human and social development in minimally stable economic conditions.

Indeed the principle of human society is the preservation and enhancement of personal life, and in like manner the principle of international

constituent nations and states. That requires the recognition by each state of its need of other states for its own existence and human development, just as social justice requires on the part of each person a recognition of the dignity of other persons. An African saying to the effect that «you never can know that a neighbour exists until you discover that you depend on him» proves enlightening in this respect (3).

Perception of one's dependence is just the opposite of resignation in the face of superior power. Thus a social order predicated on grossly unequal distribution of social benefits to one segment of the population coupled with culturally induced resignation to paucity on the part of another segment must be judged basically unsound in social terms, that is in terms of what society is all about. The consideration applies **ceteris paribus** to international society.

To determine what social groups such as the family, the various communities and the national societies in a state can do to promote social justice, one must first define social justice on the basis of the recognition of the value and dignity of persons, both individually and collectively. As humanity evolves, the practice of social justice should tend to approximate the ideal expressed in Christian and other religions as the Golden Rule.

In the international sphere, peace and international order appear dangerously precarious when they are made to depend on an equilibrium of nuclear terror or even of conventional armaments. How thoroughly unethical and absurd in human terms to base one's conception of international order on the possession of a sophisticated military and nuclear arsenal capable of annihilating the whole of humanity along with one's opponent ! There was a time when different moral precepts were thought to regulate the interrelations of states, when conquest, killing, enslavement or subjection of the populations of other states were considered worthy, valorous deeds calling forth the gratitude and respect of one's comptriots. We now realise that such deeds are subject to the same moral reprobation among states as among persons. Their instigators and perpetrators are increasingly recognized as criminals and as moral degenerates, only on a much larger scale.

We conclude from the foregoing that the stage reached by humanity in technological development outstrips its present state of moral evolution. That is why, for the first time in the history of culture, the role of philosophy as a critical and radical discipline has become vital to the survival of human society. A new ethic based on the recognition of others, persons and societies, is required for the continued existence of persons and societies. Social justice and international peace must be more consciously and critically based and that, I think, is function which philosophy capable of accomplishing.

NOTES

1. An important point needs to be made here. The word «nation» is quite frequently made to refer to the total population of a given state. This could have been true in the distant past, but large contemporary states are all multinational. The use of «nation» or «national» to refer to the people of a state amounts to a denial of the reality of national groups within the state. In many cases it belies a conscious or unconscious tendency not only to obliterate group cultural differences, but also to ensure the expansion of one cultural group at the expense of others.

2. Stressed by Dr. Nyasani of Kenya in a paper entitled «National Interests and International Co-operation for the Social Good» written in 1982 for a conference of the **International Society for Metaphysics,** in Bogota, Colombia.

3. Quoted by Dr. Nyasani in his ISM paper.

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SOME FACTORS AFFECTING THE INTERACTION BETWEEN SUNFLOWER PLANTS AND RUST FUNGUS (*PUCCINIA HELIANTHI*)

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Interaction between sunflower plants and rust fungus, ***P. helianthi*** was strongly affected by inoculation methods, inoculum density, leaf age and wetness, sunflower cultivars, photoperiod especially after host inoculation as well as survival of urediospores.

A negative correlation between photoperiod and rust infection was reported especially when plants were illuminated after inoculation. The most inhibition effect was noticed at 24h/day of exposure to light.

Germinability and infectivity of ***P. helianthi*** urediospores were strongly affected by temperature, humidity, adhesion to host tissue and storage period. Reduction in germinability and infectivity increased with increasing temperature and storage period particularly under wet conditions. Detached urediniospores lost their viability faster than attached ones under all circumstances.

Introduction

Sunflower rust disease was first recorded by Melchers (1931) in Egypt. When infections are severe, leaves sensece prematurely, and yields may be reduced to as little as 15% of attainable yield (Lal ***et al***, 1980 and Shtienberg, 1995).

However, rust reduces not only yield, but also oil percentage, seed size, weight and kernel-to-hull ratio (McMullen, 1985). Siddiqui (1975) tested susceptibility of 15 sunflower cvs. to the disease in the field and glasshouse and found that cv. 82819 had the best available resistance. However, Sivaprakasam ***et al***. (1975) noted that none of 65 varieties tested on the field was resistant to ***P. helianthi*** but 8 varieties were less susceptible than the others.

In 1980, Abo El-Dahab ***et al***., reported that varietal resistance to natural infection with sunflower rust indicated that Egyptian variety Giza 1 was the most susceptible, while the American varieties possessed considerable level of resistance. However, rust severity varies with the environment, inoculum density, host age and

cultivar resistance (Sippell and Hall, 1982; Schuh ***et al***, 1987; Velozhaban ***et al***, 1991 and Shtienberg and Vintal, 1995). Adult plant resistant reaction was observed with ***P. sorghi***/sweet corn system (Headrick and Pataky, 1987). Recently, Shtienberg and Vintal (1995) found that sunflower rust severity varies with the environment, host age and cultivar resistance.

Moisture was required for rust infection and 6 to 10h of leaf wetness was sufficient to induce infection for several rust pathogens including ***P. helianthi*** (Shtienberg and Vintal, 1995).

Moreover, susceptibility of plants to phytopathogenic fungi was increased by short days, e.g. ***P. sorghi***/corn (Ouf ***et al***, 1987) and ***P. recondita***/wheat (Eversmeyer ***et al*** ., 1988).

Rapid loss of viability of urediospores during storage frequently hampers studies of host-parasite relationships by drastically reducing the number of infection in greenhouse or field tests (Davison and Voughan, 1963). Viability of urediospores of various rust species ranges from 10 days to over 2 years (Sehein, 1962).

The present study was carried out to investigate the effect of some environmental factors and urediospore longevity on sunflower/ ***P. helianthi*** interaction.

Materials and Methods

1.1. Inoculation method:

Three inoculation methods; dusting, painting and spraying were tested. Dusting method was conducted as reported by Melching (1967) and painting as described by Walters and Murray (1992) while spraying method was performed as mentioned by Shtienberg and Vintal (1995). Only lower leaf surfaces of 15-18 days old were inoculated.

Unless otherwise stated, ***P. helianthi*** urediospores were freshly harvested from sunflower cv. Giza 1 artificially inoculated with Minia isolate. Inoculated or uninoculated (healthy) plants were covered with black plastic bags for 24h to ensure complete darkness and high humidity.

1.2. Inoculum density and leaf surfaces:

Four plants of sunflower Giza-1 cv. were grown in each of 5 clay pots No. 20 under greenhouse conditions in an experiment of complete randomized plot design with three replicates. When plants were 15-18 days old, they were inoculated with urediospores suspended in 1% starch solution at concentrations of 0.0, 4.5, 2.25 and 1.12 x 10^4 spores/ml.

1.3. Leaf age:

A staggered planting schedule was used to create plants of different age as described by Shaik *et al.* (1989). Four seeds were sown in each of five 20-cm diameter pot filled with clay soil. Experiment of complete randomized block design with three replicates (blocks) was carried out.

Plants were inoculated at the same time, when they were 11, 13, 15, 17, 19 and 21 days old (sowing day is considered as day in calculating plant age). Inoculum was prepared as described before and the lower surfaces of the 1st pair leaves (Giza-1 cv.), were inoculated with painting method as described above.

1.4. Leaf wetness:

Sunflower plants, Giza-1 cv. of 15-18 days old were inoculated, irrigated and kept under polyethylene bags for 6, 8, 12, 16 and 24h to maintain high humidity . After that, polyethylene bags were removed and leaves were dried by exposing them to gentle air ventilation for approx. 10 min.

1.5. Sunflower cultivars:

An experiment of complete randomized plot design with three replicates was carried out under greenhouse conditions.

Four sunflower cvs. i,.e. Giza-1, Giza-151, Giza-161, Miak and Two hybrids e.g. Pioneer and Hybrid No.1 were grown in clay pots No. 20. When plants were 15-18 days old, lower surfaces of first leaf pairs of 40 plants were inoculated by urediospore suspension in 1% starch. Amount of 4.5 x 10^4 spores/ml were suspended in 1% starch solution. Treated plants were covered with plastic bags for 24h. After 7 days from inoculation, plants were daily examined until the 14th day to evaluate rust severity

1.6. Effect of photoperiod:

Four experimental sets were performed during February-March, 1995 and 1996 to explore the role of photoperiods on sunflower infection. Four seeds of sunflower Giza-1 cv. were sown in clay pot No.15 in 3 replicates under greenhouse conditions. When plants were 15-18 days old, the lower leaf surfaces were painted as above mentioned. Plants were incubated in dual program illuminated incubators (Percision Scientific Inc., Model 818).

A source of light was from one side, plants were lined and a distance of 15-20cm between them and light source was kept. Plant sets were exposed to cool white flourescent light of about 1200 Lux at 20±2°C for a period of 8, 14, 18 or 24h. Illumination periods started at different times as follows:

a). From sowing date to time of rust inoculation,

b). From inoculation time to rust disease assessment,

c). From sowing date to time of rust disease assessment.

The fourth set of plants was kept under 11.5h of natural day light all time of experiment to serve as control. Four pots were used per treatment and each experiment repeated 3 times. At 15-18 day-old, plants were inoculated by painting the lower surfaces of the 1st leaf pairs as mentioned before.

Disease assessment:

Leaves were daily examined for pustules development. Latent period that necessary for 50% pustules development was recorded. Disease severity was assayed according to the number of pustules per leaf unit area as described by Peterson ***et al***. (1948).

2. Effect of storage conditions on longevity and infectivity of uredia

Urediospores of *P. heianthi* were collected from freshly sporulating pustules of artificially inoculated sunflower Giza-1 cv. Plants were grown under controlled greenhouse conditions during November 1994 and 1995 as described by Shihata *et al*., (1989). Leaf-free masses of urediospores were kept in muslin bags and placed in tightly closed containers with 100% relative humidity (r.h), or with calcium chloride to insure a dry conditions. The containers were stored for 120 days at temperatures of -15 5 20 and 30

In another experiment, infected leaves bearing sporulating pustules were collected, air dried and kept in paper bags, for 120 days under the same storage conditions. Detached and attached urediospores were tested for germinability and infectivity at 5, 10, 20, 40, 60, 80 and 120 days intervals as reported by Ouf *et al* . (1987). Infectivity of stored urediospores were tested by painting 15-day old sunflower plants Giza-1 cv. growning in greenhouse as described before.

Results And Discussion

It has been reported that there is evidence both for and against Vander Plank's hypothesis of stabilizing selection, depending on the conditions and the materials studied (Prud'Homme and Sackston, 1990). Also, it has been shown that the relative survival ability of a strain or race of a pathogen is the result of a complex of factors, including spore germination, penetration, pustule growth (Latent period), pustule density (number of pustules) and spore production (sporulation). All of these factors may be influenced by interactions among host, pathogen and

environment (Falahati-Rastegar *et al*, 1983). In the last few years, comparable studies have been done with sunflower rust (Prud'Homme and Sackston, 1990). However, to understand the epidemiology of *P. helianthi*, it is essential to know how it is affected by various factors of the environment (Shtienberg and Vental, 1995).

1.1. Inoculation method:

Of the three inoculation methods (Table 1) painting was the most effective technique. Disease severity resulting from leaf painting was 3 to 6-fold of that caused by spraying or dusting methods, respectively. Latent period was 9 days with painting and spraying techniques and prolonged to 10 days when dusting method was used. Number of pustules/cm^2 leaf area was the highest on painted leaves (18.8), moderate on sprayed (9.4) and lowest on dusted (7.4) ones.

1.2. Inoculum density:

A positive correlation between inoculum density of sunflower rust fungus and pustule numbers per unit of leaf area and rust severity was noticed (Table 2). These two parameters were increased by increasing inoculum density. These results are in agreement with the previous findings on cereal rusts (Falahati-Rastegar *et al*, 1981) and on other plant pathogen interactions (Sippell and Hall, 1982; Schuh *et al*, 1987). However, lower surfaces of leaves showed susceptibility to rust infection more than the upper one by at least 2 fold. It may be due to the number of stomata, humidity and lighting.

1.3. Leaf age:

On the other hand, number of pustules and disease severity were negatively correlated with leaf age (Table 3). Leaves of 21-day-old showed lowest number of pustules and disease severity, while 15 and 17-day-old leaves provided highest number of pustules and disease severity. Positive correlation between leaf age and disease latent period was expressed. Several reports on corn/rust system (Headrick and Pataky, 1987) and bean/rust system (Groth and Urs, 1982 and Shaik and Steadman, 1989) support this study.

1.4. Leaf wetness:

Data indicate that leaf wetness (Table 4) is an important factor for sunflower rust infection. Longer duration of leaf wetness proved sufficient disease severity. These findings are in line with several reports on various rust pathogens, e.g. *P. helianthi* (Shtienberg and Vintal, 1995), *P. recondita* (Eversmeyer *et al*, 1988 and de Vallavieille *et al*, 1995) and *P. orghi* (Headrick and Pataky, 1987).

Table (1): Effect of different methods of artificial inoculation on sunflower rust infection under controlled greenhouse conditions.

Inoculation method	Incubation period (day)	No. pustules/cm^2 leaf area	Disease severity %
Painting	9	18.8	65
Spraying	9	9.4	20
Dusting	10	7.4	10
L.S.D at 0.05		3.36	

Table (2): Response of sunflower Giza-1 cv. to rust infection with Minia isolate, as affected by inoculum density and infection site

Leaf surface	Inoculum density X10^4 spores/ml	Incubation period	No of. pustules/cm^2 leaf area	Disease severity %
Lower surface	1.12	10	4.4	20
	2.25	10	6.6	30
	4.5	9	17.9	65
	9.0	8	Uncountable	>90
Mean		9.25		50.5
Upper surface	1.12	10	1.4	10
	2.25	10	3.7	20
	4.5	10	6.2	30
	9.0	9	12.2	50
Mean		9.7	5.85	27.5

L.S.D at 0.05 0.56

inoculum 0.79

interaction (LxI) = 7.1

Table (3): Effect of leaf age on sunflower rust infection.

Leaf age (day)	Incubation period	No. pustules/cm^2 leaf area	Disease severity %
11	9	11.9	55
13	9	11.9	55
15	9	19.2	65
17	9	20.4	65
19	10	7.2	35
21	10	5.9	15
L.S.D at 0.05		1.76	

Table (4): Effect of leaf wetness on sunflower rust infection.

Leaf wetness duration (h)	Incubation	No. pustules/cm^2 leaf area	Rust severity %
6	-	-	-
8	9	7.2	40
12	9	8.7	45
16	9	14.2	65
24	9	15.1	65
L.S.D at 0.05		1.21	

1.5. Reaction of some sunflower cultivars:

Differences in susceptibility of sunflower cvs to *P. helianthi* infection have been reported by (Abo El-Dahab *et al*, 1980 and Gulya *et al*, 1989). Similar findings were obtained during the present investigation. Data indicate that sunflower Giza-1 cv was the most susceptible to rust infection followed by other Egyptian cultivars Giza-161 and Giza-151, while Miak cv. and sunflower hybrids were the least (Table 5).

1.6. Effect of photoperiod:

Photoperiods have substantial effect on sunflower rust infection (Table 6). A negative correlation between photoperiod and rust infection was obtained particularly when plants were illuminated after inoculation. When the photoperiod was more than 14h/day, the number of pustules/cm^2 leaf area and disease severity highly were

Table (5): Reaction of some sunflower cultivars to Minia isolate of rust fungus under controlled greenhouse conditions.

Sunflower cv.	Incubation	No. pustules/cm^2 leaf area	Disease severity %
Giza-1	9	18.3	65
Giza-151	9	15.3	60
Giza-161	9	16.4	60
Miak	9	13.2	55
Pioneer	9	12.7	55
Hybrid-1	9	12.8	55
L.S.D at 0.05		1.15	

Table (6): Reaction of sunflower Giza-1 cv. to rust infection as affected by the photoperiods. Plants were illuminated;

Photoperiod hour/day	Incubation period, day			Number of pustules/ 1cm^2 leaf area			Disease severity %		
	Illuminated treatments								
	a	b	c	a	b	c	a	b	c
8	9	9	9	13.8	11.4	11.2	50-60	50	50
14	9	9	10	13.6	9.9	7.2	50-60	40-50	30
18	9	11	11	13.6	7.5	5.3	50-60	30	20
24	9	11	11	13.3	5.9	3.2	50-60	20	10-20
Control (natural day light). Day length was about 11.5h	9	9	9	15.5	15.5	15.5	60-70	60-70	60-70
L.S.D at 0.05				0.92	1.23	1.46			

a. from sowing date to inoculation time,
b. from inoculation time to disease assessment and
c. from sowing date to disease assessment

Table (7): Effect of temperature, humidity and storage period on germinability (Germ.) and infectivity (Dis. Sev.) of detached *P. **helianthi*** urediospores

Storage period, day	Germination percentage and infectivity of urediospores under different stored conditions															
	-15°C				5°C				20°C				30°C			
	Wet		Dry		Wet		Dry		Wet		Dry		Wet		Dry	
	Germ %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev %
5	54.7±3.2*	55	83.3±1.8	70	50.3±7.9	50	80.6±4.6	70	32.2±1.7	35	61.8±4.3	65	8.0±0.5	10	34.8±6.8	35
10	45.0±2.1	40	80.9±4.7	70	26.0±5.6	25	60.0±4.8	65	19.5±4.2	20	55.0±9.1	60	4.0±1.7	3	14.5±1.2	15
20	25.7±1.1	15	79.4±4.5	70	15.5±2.5	15	55.0±2.9	55	6.2±0.8	4	31.8±1.9	35	1.6±0.3	0.0	7.8±0.4	10
40	13.5±1.5	10	77.0±2.5	65	6.6±0.3	5	34.0±1.1	35	0.0	0.0	16.5±1.2	15	0.0	0.0	3.7±1.5	0.0
60	2.7±0.5	1	26.8±1.1	30	2.1±0.2	1	13.4±0.7	15	-	-	0.0	0.0	0.0	0.0	0.0	-
80	1.9±1.1	0.0	12.0±0.2	10	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-
120	0.0	-	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-

* Data are means of one experiment in 4 replicates ± standard deviations (SD)

Table (8): Effect of temperature, humidity and storage period on germinability (Germ.) and disease severity of attached ***P. helianthi*** urediospores

Storage period, day	Germination percentage and infectivity of urediospores under different stored conditions															
	-15°C				5°C				20°C				30°C			
	Wet		Dry		Wet		Dry		Wet		Dry		Wet		Dry	
	Germ %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev. %	Germ. %	Dis. Sev. %	Germ. %	Dis Sev %	Germ. %	Dis Sev %
5	78.4±7.0*	65	91.8±2.2	70	60.6±3.3	60	90.7±1.6	70	38.3±1.8	45	68.2±1.9	65	8.4±0.5	10	17.2±1.3	20
10	65.6±5.0	55	90.3±3.9	70	56.2±3.1	60	82.2±1.9	65	31.8±2.7	40	66.7±2.2	60	5.6±0.6	5	16.1±0.7	7
20	58.3±7.9	50	88.3±4.7	70	48.4±9.4	50	72.4±4.1	65	15.5±1.1	15	62.0±7.1	55	3.4±1.1	0.0	15.2±1.5	15
40	31.1±6.8	20	80.8±6.9	65	18.5±9.3	15	62.0±8.2	60	5.0±2.8	2	54.8±4.8	50	3.0±1.7	0.0	11.6±2.3	5
60	21.7±1.8	20	69.4±4.4	60	16.0±4.9	15	30.0±10.4	25	0.0	-	20.8±5.2	10	0.0	-	7.5±2.6	5
80	18.7±2.4	10	59.8±1.6	50	0.0	-	15.6±4.5	15	0.0	-	10.5±3.4	5	0.0	-	5.9±1.8	1
120	9.0±1.5	5	15.0±3.5	15	0.0	-	11.8±1.9	5	0.0	-	0.0	-	0.0	-	0.0	-

* Data are means of one experiment in 4 replicates ± standard deviations (SD)

decreased and disease latent period was prolonged as well. The most disease-suppression was experienceed when the illumination period was 24h/day. This investigation concludes that photoperiod has direct effect on sunflower/rust fungus interaction. Such findings are in agreement with reports on other plant/rust fungus interaction (Ouf *et al* , 1987 and Eversmeyer *et al* , 1988).

2. Effect of storage conditions on longevity and infectivity of uredia:

Germinability and infectivity of *P. helianthi* urediniospores are strongly affected by temperature, humidity, adhesion to host tissue and storage period (Table 7 and 8). Germinability as well as infectivity gradually decreased with increasing temperature and storage period particularly under wet storage conditions. Detached urediospores lost their viability faster than attached ones under all circumstances. However, at 30°C, viability was lasted at 20 and 40 days under wet and dry storage conditions, respectively. Under -15°C viability was prolonged to 60 and 120 days in case of detached and attached spores, respectively, even under dry or wet conditions. But the percentage of survival urediniospores was different. Data also indicate that there was direct correlation between urediospores germinability and aggressiveness. Similar findings on other plant/rust fungi interactions have been reported elsewhere (Shihata *et al* , 1989 and Eversmeyer and Kramer, 1995).

References

Abo El-Dahab, M.K.; Tarabeih, A.M. and Mohamed, S.E. (1980): Studies on sunflower diseases in Egypt. Studies on sunflower rust and its control. ***Egypt. J. Phytopathology***, 12: 123-130

Davison, A.D. and Voughan, E.K. (1963): Longevity of urediospores of race 33 of ***Uromyces phaseoli*** var. ***phaseoli*** in storage. ***Phytopathology***, 53: 736-737.

de Vallavieille, P.C.; Huber, L.; Leconte, M. and Goyeau, H. (1995): Comparative effects of temperature and interrupted wet periods on germination, penetration and infection of ***Puccinia recondita*** F.sp ***tritici*** and ***P. striiformis*** on wheat seedlings. ***Phytopathology***, 85: 409-415.

Eversmeyer, M.G.; Kramer, C.L. and Hassan, Z.M. (1988): Environmental influences on the establishment of ***Puccinia***

recondita infection structures. ***Plant Disease***, 72: 409-412.

Eversmeyer, M.G. and Kramer, C.L. (1995): Survival of ***Puccinia recondita*** and ***Puccinia graminis*** urediospores exposed to temperatures from subfreezing to 35°C. ***Phytopathology***, 85: 161-164.

Falahati-Rastegar, M.; Manners, J.G. and Smart, J. (1981): Effects of temperature and inoculum density on competition between races of ***Puccinia hordei***. ***Trans Br. Mycol. Soc.***, 77: 359-368.

Falahati-Rastegar, M.; Manners, J.G. and Smart, J. (1983): Factors determining results of competitions between physiologic races of ***Puccinia hordei***. ***Trans Br. Mycol. Soc.***, 81: 233-239.

Groth, J.V. and Urs, N.V.R.R. (1982): Differences among bean cultivars in receptivity to ***Uromyces phaseoli*** var. ***typica***. ***Phytopathology***, 72: 374-378.

Gulya, T.J.; Miller, J. and Rashid, K.Y. (1989): Rust races occurring in North America in 1988 and resistance of sunflower hybrids to races 1 and 3. ***Proc. Sunflower Res. Workshop***, pp 19-20.

Headrick, J.M. and Pataky, J.K. (1987): Expression of partial resistance to common rust in sweet corn hybrids at various host growth stages. ***Phytopathology*** , 77: 454-458.

Lal, T.B.B.; Mathur, S.; Chakravarti, B.P.; Singh, R.B. and Singh, R.D. (1980): Increase in sunflower yield by controlling rust with systemic and non systemic fungicides. ***J. Turk Phytopathology***, 9: 89-96.

Melching, J.S. (1967): Improved deposition of airborne urediospores of ***Puccinia graminis*** and ***Puccinia striiformis*** on glass slides and on wheat leaves by use of a turntable. ***Phytopathology***, 57: 647.

Melchers, L.E. (1931): A check list of plant disease and fungi occurring in Egypt. ***Trans Kansas Acd. Sci.***, 34.

McMullen, M.P., ed. (1985): Sunflower production and pest management. N.D. State Univ. ***Ext. Bull.***, 25.

Ouf, M.F.; Gazar, A.A.; Shihata, Z.A. and H.N. Soliman (1987): Some factors affecting spore germination, penetration and infection by maize rust. ***Minia J. Agric., Res.&Dev.***, 9: 1133-1149.

Peterson, R.F.; Campbell, A.B. and Hannah, A.E. (1948): A diagrammatic scale for estimating rust intensity on

leaves and stems of cereals. ***Can J. Res. (Sect. C)***, 26: 496-500.

Prud Homme, A-M and Sackston, W.E. (1990): Relative fitness of races 1(0) and 3(0, 1) rust (***Puccinia helianthi***) in mixtures on susceptible sunflower (***Helianthus annuus***). ***Can. J. Bot.***, 68: 1602-1608.

Schuh, W.; Jeger, M.J. and Frederiksen, R.A. (1987): The influence of soil temperature, soil moisture, soil texture and inoculum density on the incidence of sorghum downy mildew. ***Phytopathology***, 77: 125-128.

Sehein, R.D. (1962): Storage viability of bean rust urediospores. ***Phytopathology***, 52: 653-657.

Shaik, M. and Steadman, J.R. (1989): The effect of leaf developmental stage on the variation of resistant and susceptible reactions of ***Phaseolus vulgaris*** to ***Uromyces appendiculatus. Phytopathology***, 79: 1028-1035.

Shaik, M.; Dickinson, T.A. and Steadman, J.R. (1989): Variation in rust susceptibility in beans: predicting lesion size from leaf developmental stage measured by leaf age, length and plastochron index. ***Phytopathology***, 79: 1035-1042.

Shihata, Z.A.; Abdel-Latif, M.R.; El-Sadek, S.A.M. and Soliman, H.N. (1989): Viability of urediospores and chemical control of common maize rust (***Puccinia sorghi*** Schw). ***Minia J. Agric., Res. & Dev.***, 11: 739-757.

Shtienberg, D. (1995): Rational suppression of sunflower rust: Development and evaluation of an action threshold. ***Plant Diseases***, 79: 506-510

Shtienberg, D. and Vintal, H. (1995):Environmental influences on the development of ***P. helianthi*** on sunflower. ***Phytopathology***, 85: 1388-1393.

Siddiqui,M.Q.(1975): Identification of rust resistant cultivars in sunflower germ-plasm. Indian ***Phytopathology***, 27: 393.

Sippell, D.W. and Hall, R. (1982): Effects of pathogen species, inoculum concentration, temperature and soil moisture on bean root rot and plant growth. ***Can. J. Plant Pathology***, 4: 1-7.

Sivaprakasam, K.P.; Pillayarsamy, K.; Ganapathy, S. and Chidambaram, S. (1975): Note on the varietal response of sunflower (***H. annuus*** L.) to rust (***Puccinia helianthi*** Schw). ***Madras Agricultural Journal***,

62:2 (C.F. Rev. Plant Path., 55: 5867).

Velozhaban R.; Narayanasamy, P.and Jeyarajan, R. (1991): Reaction of sunflower germplasm to rust disease in Tamil Nadu. ***Indian Phytopathology***, 44(2): 239-241.

Walters, D.R. and Murray, D.C. (1992): Induction of systemic resistance to rust in ***Vicia faba*** by phosphate and EDTA. Effects of calcium. ***Plant Pathology***, 41: 444-448.

بعض العوامل المؤثرة على التفاعل بين نباتات عباد الشمس وفطر الصدأ (*باكسينيا هيليئنثاى*)

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تأثر التفاعل بين نباتات عباد الشمس وفطر الصدأ تأثرا واضحا بعدة عوامل أهمها طريقة العدوى ، كثافة اللقاح وسطح الورقة ، وعمرها ، ورطوبتها ، أصناف عباد الشمس المختبرة ، وحيوية الجراثيم اليوريدية ، فترات تعريض العائل للإضاءة خصوصا بعد إحداث العدوى . وبلغت شدة الإصابة الناتجة عن العدوى بطريقة طلاء الأوراق بالجراثيم ٣-٦ أضعاف تلك الناتجة عن أحداث العدوى بالرش أو تعفير الأوراق بالجراثيم على التوالى .

كان السطح السفلى للورقة كان أكثر قابلية للإصابة من السطح العلوى . وكانت الإصابة متضاعفة على السطح السفلى كما أظهرت الدراسة علاقة عكسية بين شدة الإصابة وعمر الورقة.

صنف جيزة ١ هو أكثر الأصناف قابلية للإصابة يليه الأصناف المصرية الأخرى جيزة-١٦١ ، جيزة-١٥١ . بينما كان الصنف مياك والهجن اقل قابلية للإصابة .

كان لفترات الإضاءة تأثيرا واضحا على إصابة عباد الشمس بالصدأ . مع وجود علاقة عكسية بين فترة الإضاءة وشدة الإصابة خصوصا إذا تعرضت النباتات لفترات إضاءة أطول بعد العدوى الصناعية .

إنبات وقدرة الجراثيم اليوريدية للفطر على إحداث الإصابة تاثرت بالحرارة ، الرطوبة ، إلتصاق الجراثيم بنسيج العائل وبفترة التخزين . إزداد الإنخفاض فى الإنبات والقدرة المرضية للجراثيم اليوريدية بزيادة درجة الحرارة وطول فترة التخزين خاصة تحت ظروف الرطوبة العالية للجراثيم الحرة "المفصولة من العائل" .